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MACHINE DESIGN

AS IT AFFECTS

ENGINEERING—PRODUCTION—SALES

2⅓ YEARS-75,000 MILES

in the heaviest type of service

WITH NO ADDED LUBRICANT!

THE advertisement reproduced above, announcing the adoption of NORMA-HOFFMANN PRECISION Bearings in the eight motors of the Great Northern electric locomotive, appeared in 1928. The following comments on the performance of these bearings since then, are extracted from a letter by the Electrical Engineer in Charge of Operation for the Great Northern Railway:

"* * * From 20 degrees below zero weather to 110 degrees summer heat the locomotive to date, after 28 months of road service, has been run about 75,000 miles. * * * Every four months a different motor was taken down and bearings thoroughly checked for condition as well as grease tested for lubricating quality. Two of the motors have never been disturbed, as in no case has it been found necessary to renew or add any grease. * * * After 2⅓ years and 75,000 miles of service, a conservative figure on the performance to be expected from this type of bearing in heavy traction service is about one greasing every 100,000 miles, and possibly 150,000 miles would be a safe maximum."

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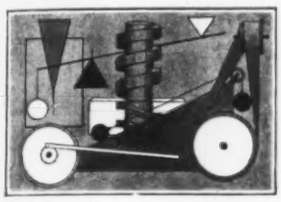
NORMA-HOFFMANN BEARINGS CORPORATION STAMFORD CONN., U.S.A

MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 3 **October, 1931** **Number 10**



Forthcoming ISSUES

RECEIVING impetus on account of the unique method of mounting the engine in the new model Plymouth car, the subject of flexible mounting of machinery is one of timely interest. MACHINE DESIGN *therefore has arranged for the publication of an authoritative article on this subject in an early issue.*

The contribution will not deal purely with the mounting of automobile engine units but will cover spring mounting generally, outlining the underlying theory and including a number of illustrative examples of interest to designers in various fields.

L. E. Jermy

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FRANKLIN H. JOHNSON, *Publisher*

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WHY BORROW FROM HIM?

THE ink is just dry on the eighth edition of New Departure's price and data book . . . containing important revisions and additions to previous listing of types, capacities, dimensions and mounting details of New Departure Ball Bearings. Every engineer, designer, and purchasing man should have one. Why borrow, when your copy is ready to "take off" to you. Ask for data book "S". The New Departure Mfg. Company, Bristol, Connecticut; Detroit, Chicago and San Francisco.

1789

NEW DEPARTURE BALL BEARINGS

Itemized Index, October, 1931

Key: Edit, Editorial Pages; Adv, Advertising Pages; R, Right hand column; L, Left hand column

Compiled for the assistance of engineers confronted with specific design problems

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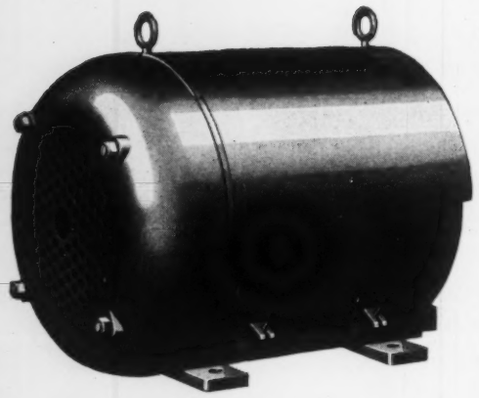

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and wipe these stainless steel corrugations . . . .

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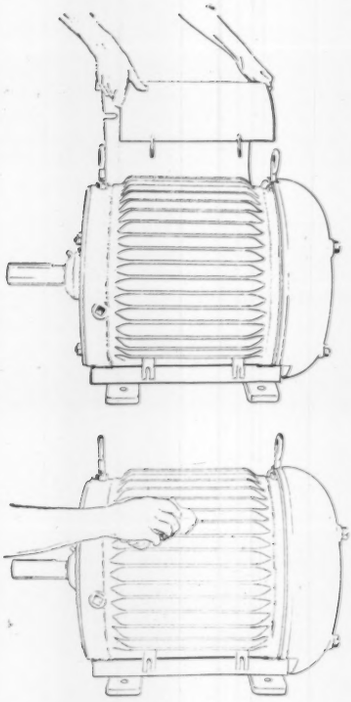

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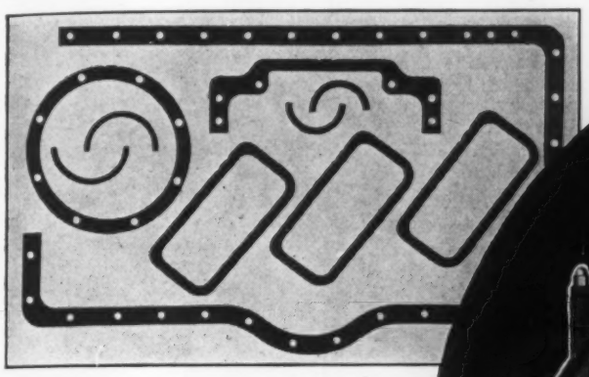

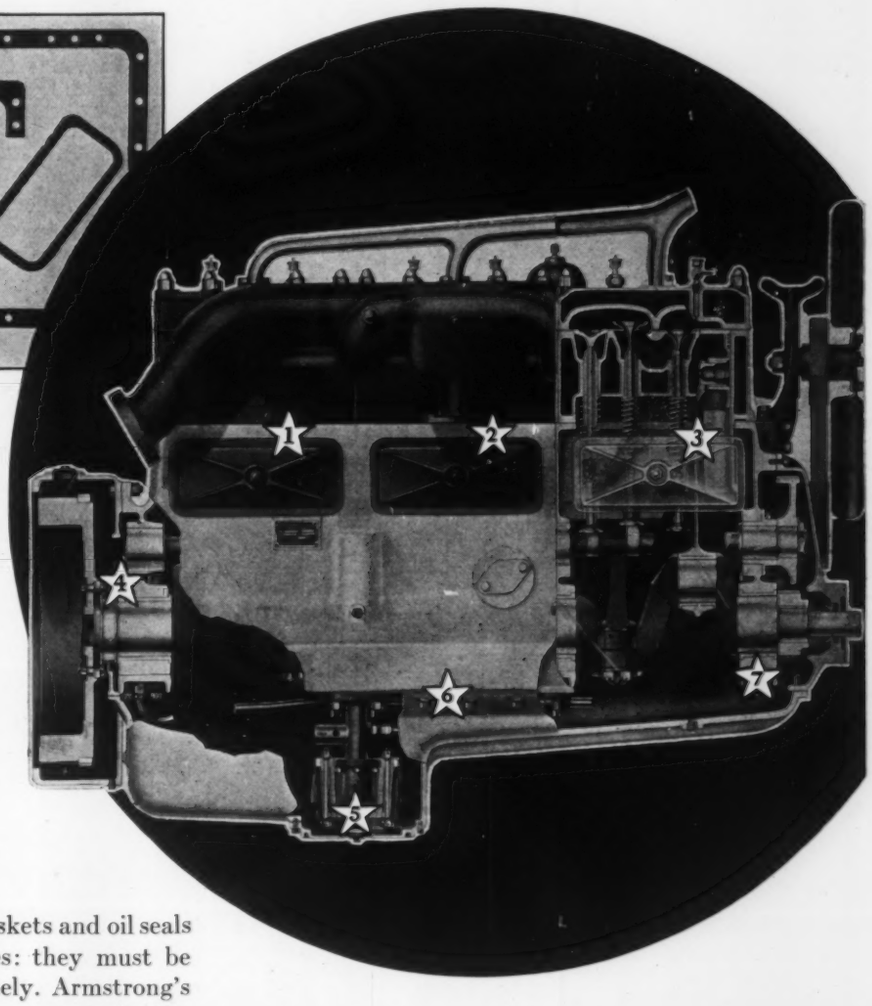

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Speed of extension shaft based on motor speed of 8000 R.P.M. under load.
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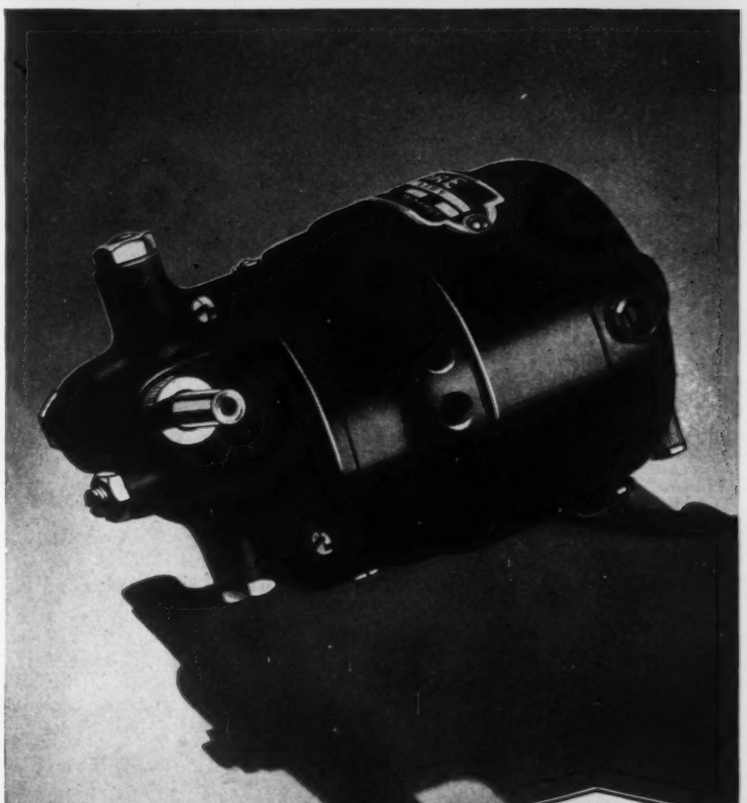


DUMORE
FRACTIONAL HORSEPOWER MOTORS

Calendar of Meetings and Expositions

Oct. 12-16—National Safety council. Annual meeting and exposition to be held at Stevens hotel, Chicago. Included in the papers to be presented is, "Analysis of Accident Causes in the Metals Industry," by C. P. Waite. W. H. Cameron, 20 North Wacker Drive, Chicago, is secretary.

Oct. 12-16—American Gas association. Thirteenth annual convention and exposition at Municipal auditorium, Atlantic City, N. J. Kurwin R. Boyes, 420 Lexington avenue, New York, is secretary.

Oct. 14-16—Society of Industrial Engineers. Annual meeting to be held in Pittsburgh. Geo. C. Dent, 205 W. Wacker drive, Chicago, is secretary.

Oct. 15-16—Gray Iron institute. Topics scheduled for the technical sessions of the fourth annual meeting at West Baden Springs hotel, West Baden, Ind., include: "Interpretations of the Technical Bulletin," "Proposed Specifications," and "Standard Practices and What They Mean to the Industry," by Oliver Smalley. Arthur J. Tuscany, Terminal Tower building, Cleveland, is manager.

Oct. 15-17—American Gear Manufacturers association. Included in the papers to be presented at the semiannual meeting at William Penn hotel, Pittsburgh, are: "Good Practice in the Manufacture of Speed Reducers," by P. C. Day, "The Practical Aspect of Tip Relief," by T. R. Rideout, and "The Theoretical Aspect of Tip Relief," by R. E. Peterson. There is a technical standardization program planned for the evening of Oct. 15. T. W. Owen, 3608 Euclid avenue, Cleveland, is secretary.

Oct. 15-16—American Society of Mechanical Engineers. The sixth national meeting and exhibit of machinery of the wood industries division to be held at Robert E. Lee hotel, Winston Salem, N. C., will include papers on "Types of Hydraulic Presses in Wood-Gluing Processes," by H. G. Francis, "Double-End Tenoner and Its Use," by J. H. Mansfield, and "Adaptability and Application of Modern Dust-Collecting Systems," by W. E. Allington. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary.

Oct. 21-23—National Association of Farm Equipment Manufacturers. Annual meeting at Congress hotel, Chicago. H. J. Sameit, 608 South Dearborn street, Chicago, is secretary.

Oct. 22—Steel Founders Society of America. Meeting at New York. Granville P. Rogers, 932 Graybar building, New York, is general manager.

Oct. 23—American Iron and Steel institute. Annual meeting at Hotel Commodore, New York. H. H. Cook, 75 West street, New York, is secretary.

Oct. 26-31—Dairy and Ice Cream Machinery and Supplies association. In conjunction with the annual meeting, which will include technical papers and discussions, to be held at Atlantic City, N. J., will be an exhibit of the latest improved machinery for all divisions of dairy operation and ice cream manufacture. C. E. Breece, 225 West Thirty-fourth street, New York, is secretary.

Nov. 4-5—Chamber of Commerce of the United States. Annual meeting at Spokane, Wash. D. A. Skinner, 1615 H street, N. W., Washington, is secretary.

Nov. 10-13—National Association of Practical Refrigerating Engineers. Meeting and exposition to be held at Rice hotel, Houston, Texas. Edward H. Fox, 435 North Waller avenue, Chicago, is secretary.

Nov. 11-13—International Acetylene association. Annual meeting to be held at Chicago. A. Cressy Morrison, 40 East Forty-second street, New York, is secretary.

No. 17-19—American Management association. Co-ordinated industrial planning meeting and annual convention to be held at New York. W. J. Donald, 20 Vesey street, New York, is managing director.

Nov. 18-20—Conference on Metals and Alloys. Technical papers, discussions, and exhibits are planned for this conference at Case School of Applied Science, Cleveland. sponsored by the school in conjunction with the Cleveland Engineering society. For further information address Fred L. Plummer, Case School of Applied Science, Cleveland.

Nov. 30-Dec. 5—American Society of Mechanical Engineers. Annual meeting to be held at Engineering Societies building, New York. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary.

Association of Railway Electrical Engineers. Meeting of the society scheduled for Oct. 21 has been postponed indefinitely.

MACHINE DESIGN

THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO

October, 1931 Vol. 3—No. 10

Unusual Mining Machine Eliminates Blasting Hazard

By Harold B. Veith

Editorial Representative, Machine Design

Fig. 1—Coal saw showing feed and lift cylinders. (Insert)—Sawed coal

SINCE the introduction of coal mining by machinery the innovation has proved the value of mechanization in the industry. Tracing the development of machines for this work, a healthy progress in design is revealed including the elimination of blasting, probably the greatest hazard to the occupation of mining. Engineers schooled in the needs of the industry have devised a machine which saws the coal into blocks such as shown in the insert, Fig. 1. This method of mining procedure and the use of a breaker pad obviates the necessity for undercutting, drilling and powder blasting.

The coal saw referred to, seen in Figs. 1 and 8, is manufactured by Joy Bros. Inc., Marion, O. This unit was evolved through a period of concentrated effort on the part of its designers to produce a machine which could be employed in the mine to saw coal in blocks weighing between 1500 and 3000 pounds apiece. An earlier model of the machine was built for experimental purposes which incorporated two saw blades running in parallel, but this later was redesigned as a stronger and more rigid unit employing a single saw only.

After many experiments with complicated gear reductions and friction feed clutches the designers developed and embodied in this machine a unique system of hydraulic control. The advantage of this lies in the one fact that for operation of a machine engaged in coal cutting it is desirable to employ feeding and driving devices which provide smooth and positive action and which can be varied infinitely. The coal saw is controlled principally by a hydraulic system as outlined in Fig. 2. Operation of the complete machine, however, is under the control of two electric push buttons, one on either side of the frame. Either of these will turn on or off the 10 horsepower, totally enclosed, continuous duty motor which drives the sawing chain and the hydraulic gear pump.

In appearance the new model saw is changed considerably over the former unit although the principle of construction is practically the same. Following the general assembly drawing, Fig. 3, and also the views of the machine in Figs. 1 and 8. it will be seen that the parallelogram construction of the upper section of the machine permits cutting vertically through a coal seam. The lift of this section of the unit is accomplished by hydraulics through the use of two double acting cylinders, one on each side of the frame. If it is desirable to start the cutting at

the top of the seam and cut downward the cylinders then act to lower the upper frame, drawing down the saw accordingly for a shear cut.

In connection with the parallelogram construction of the swinging frame it is interesting to study some of the features which have been

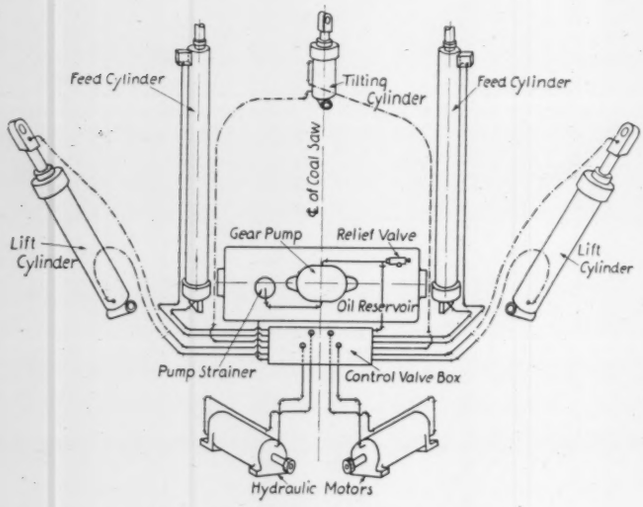


Fig. 2—Hydraulic system which furnishes pressure for the five operating cylinders and rope drum motors

incorporated in it. The top of the frame is a solid plate of steel which imparts rigidity to the unit. The four parallel nickel steel bars at the sides are hinged at their ends to the casting which carries the revolving head of the saw, and to the vertical back frame of the machine. Support of the saw by these parallel bars permits all vertical positions of the saw necessary to adapt it to various heights of coal seams mined.

The piston rods of the lift cylinders are hinged to the upper side frame members. There is, however, a unique feature of design at this point, which relieves the upper bars of the strain in lifting the frame. Midway between the hinged ends is a rib which also is hinged between the upper and lower parallel bars. When the lift is effected by the cylinders, forcing upward the top bars, this rib, located at the point of pressure, transfers an equal portion of the strain to the lower bars of the frame. This section also serves to stiffen the parallelogram formed by the bars.

In addition to the two lift cylinders there are two double acting cylinders for controlling the forward and backward movement of the machine in the process of cutting. As can be seen in Figs. 1 and 8, these are in a horizontal position at the bottom of each side of the unit. It should be noted that the base of the machine is in two parts, one sliding within the other. Guideways are provided on the sub-base or pan that rests directly on the mine floor and it is in these that the operating mechanism of the saw slides.

Feed Cylinders Sump Saw Into Coal

When it is necessary to sump the tip of the saw into the coal the operator turns the necessary valve, and hydraulic pressure from the gear pump forces the pistons ahead thereby moving the frame of the machine forward on its base. For backward movement a hinged extension to the sub-base or pan is provided in order that the machine may be moved still further to the rear than the position permitted by the sub-base proper. The backward movement is obtained by turning the respective valve on the control box which is located on the rear end of the unit in order that the operator can take up a position out of danger that may arise from falling coal. The location of this control box may be seen in Fig. 5.

Augmenting the cylinders for vertical and horizontal operation, there is another which performs a specific function for the head which

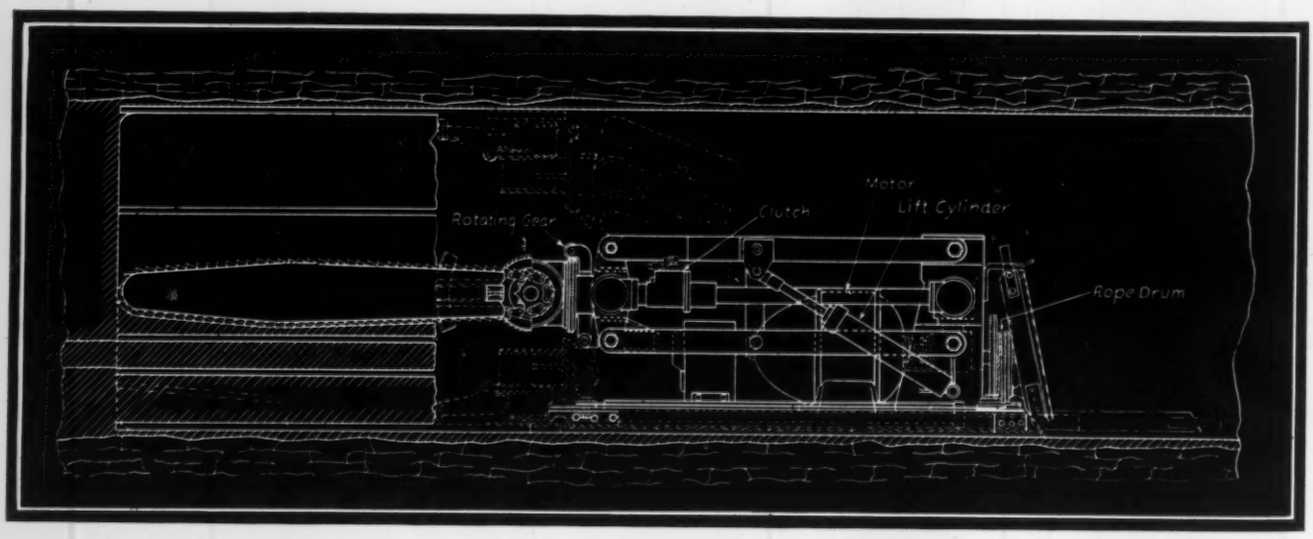


Fig. 3—Side elevation of coal saw in which the parallelogram construction is shown

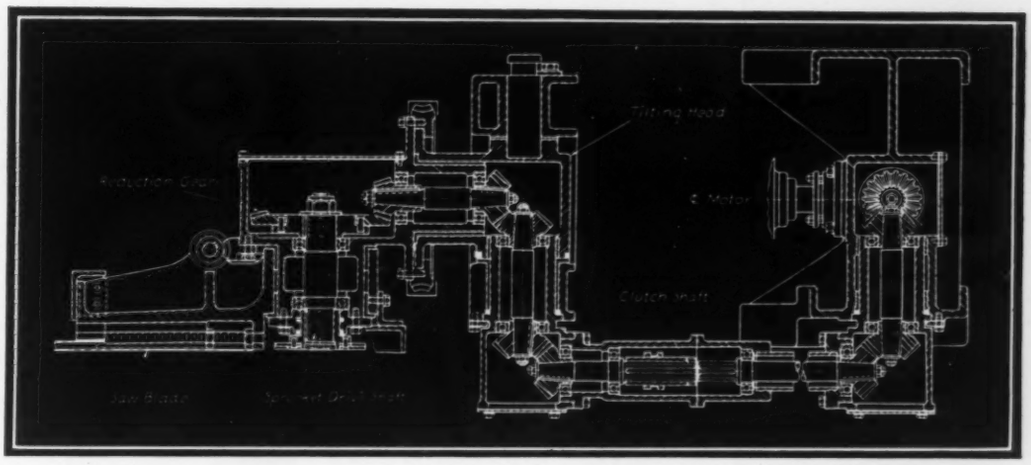


Fig. 4—Driving arrangement for transmitting power to the cutting chain from the electric motor located at rear of the machine

holds the saw blade. When it becomes necessary, due to irregularities of the mine floor, to adjust the saw at an angle above or below the parallel position in which it normally is maintained, the valve which controls this cylinder is operated, and through a linkage the piston swings the saw blade in the desired direction. This may be five degrees either above or below the parallel position.

A feature of the pump which provides pressure for the hydraulic system is the simplicity of its mounting. Two bolts only are required to hold it in position, an innovation that was designed to simplify the installation and removal of the mechanism. It is capable of developing a pressure of 1500 pounds; however, the average operating pressure required by the machine is between five and six hundred pounds. In the hydraulic line a short distance beyond the discharge outlet of the pump is located a specially designed, balanced type relief valve which will relieve the pressure should any of the various feeds of the machine reach their limits unnoticed, thereby endangering the machine parts by the building up of pressure.

Rope Drums Hydraulically Driven

It was at this point that friction devices first were tried to develop means of varying the speed and reversing the drums for coiling the wire ropes to pull the machine in cutting horizontally across the coal seam or loading it on a truck for transportation. Hydraulic lift and feed had already been designed into the unit, however, and it therefore was logical that engineers should develop a hydraulic drive for the rope drums.

These drums consequently are driven individually by hydraulic motors designed by the engineering department of the company, and in this case as elsewhere on the machine the control is obtained by means of valves located on the control panel. The hydraulic motors have a high starting torque and the rope pull is proportionate to the pressure applied to the hydraulic motors. The drums are driven through ring gears attached to them by welding. Details of the drums are given in Figs. 5 and 7. As shown, an eccentric device coupled with the shaft of each drum is designed to allow the ring gear to be thrown in and out of mesh with the pinion drive of its respective hydraulic motor.

To keep the drums from turning too freely on their shafts after the gears have been disengaged, thus causing troublesome entanglement of the wire rope, there has been included in the design of these parts a spring loaded friction plate. When the feed rope drums are released the friction plates prevent unwinding due to rope recoil. They do not, however, hold the drums too firmly, thus permitting rotation by hand if desired.

From the drums the wire rope is taken

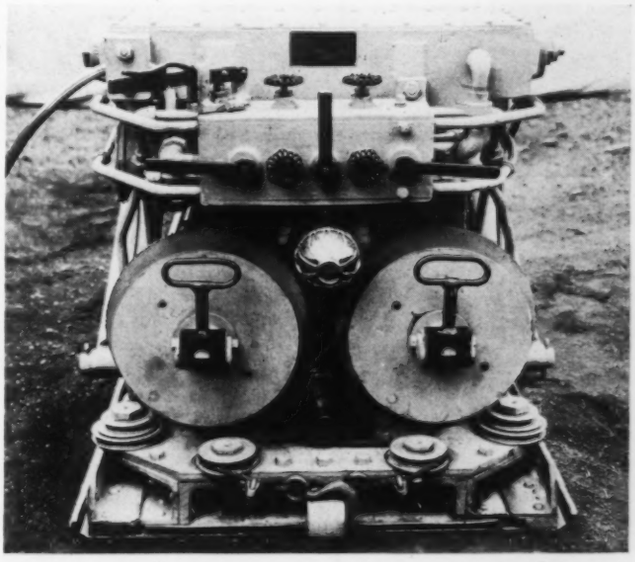


Fig. 5—Rear view of coal saw. Hydraulic control box and rope drums are shown

through an arrangement of sheaves to the anchor jacks which are anchored between the roof and floor of the mine room at a point adjacent to the sides of the machine. In making horizontal cuts the hydraulic motors drive the drums which, in revolving, coil up the wire rope

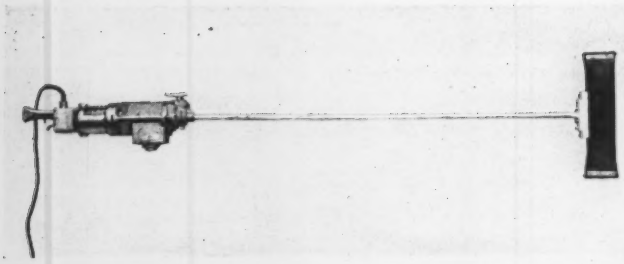


Fig. 6—Breaker pad for dislodging sawed coal

thus dragging the machine sidewise across the floor. For making this type of cut, however, it is necessary to place the saw blades in a position 90 degrees from that necessary in making a shear or vertical cut. A worm gear drive is provided for rotating the sawing mechanism through a range of 360 degrees. By a hand crank on the end of the worm shaft the operator is able to rotate the saw to the desired position.

Driving of the saw chain incorporates several novel design characteristics. It was necessary to lay out this drive for satisfactory performance regardless of the height of the cutting chain from the base of the machine. The electric motor is located in the rear and it therefore was necessary to arrange the drive shaft along the left side of the machine to reach the saw head on which the sprocket for driving the cutting chain is located. In Fig. 4 is shown the driving arrangement. Hardened and ground chrome vanadium steel gears and chrome nickel steel shafts are used throughout. The arrangement of miter gears permits changes in the angle of the drive shaft, enabling it to revolve uninterruptedly in any position. These operate on ball bearings in a bath of oil and are enclosed in oiltight dust proof steel housings. A feature of construction embodied in the driving mechanism of the machine rests in the fact that the gears themselves are carried by ball bearings surrounding elongated hubs, resulting in the shafts being subjected to torsional loads only.

In designing this drive it also was necessary to keep the dimensions of the parts down and to accomplish this, gear diameters were selected so that the shafts would turn 1750 revolutions per minute up to the point of reduction which is at the head of the machine. Here the speed is reduced to drive the chain at a continuous rate of 600 feet per minute.

The drive also is worthy of note in that all gears up to the point of reduction are the same size, thus making them interchangeable. This fact is important from the standpoint of standardization and also simplifies replacement from stock. The drive shaft of the gear pump takes its power off this drive.

The construction of the saw embodies a single strand chain, the cutting teeth of which are tipped with a special alloy to withstand sawing of materials encountered in the coal strata. Power is transmitted to the sprocket which straddles the chain, through a gear set at the head of the machine.

In order to stop the cutting chain without shutting off the electric motor a coupling embodying a splined sleeve engaging the end of a splined shaft is provided which acts as a clutch. Turning the handle that projects from the housing surrounding the coupling, shifts the splined sleeve which engages or disengages the shaft ends. It can be locked either in or out of engagement by means of a knurled head screw.

Fig. 8—Coal saw positioned for vertical cut

There has been developed in connection with this coal saw a separate device known as the breaker pad. It is by the employment of this unit, a view of which is shown in Fig. 6, that the coal after it has been sawed into block form can be dislodged from the seam without the use of an explosive. A small gear pump driven by a quarter horsepower motor furnishes the hydraulic pressure to inflate the rubber lined fabric pad attached to the end of a pressure conducting tube. A valve is provided to direct the pressure into the pad which is inserted in the saw cut in a deflated condition. Pressure amounting to a total of 30,000 pounds is obtainable with this breaker pad.

The Joy coal saw while yet a new development has stood the test highly satisfactorily in the mine. It is the creation of J. F. Joy whose work in the building of other mining equipment is well known.

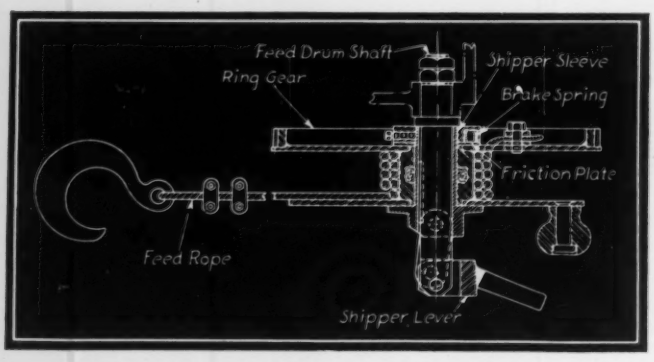


Fig. 7—Cross section of feed rope drum

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Air Conditioning Opens New Markets

NO QUESTION exists as to the tremendous possibilities for design that are opening up in the refrigerating and air conditioning field. Indicative of the present trend, two notable systems have been introduced recently, one for cooling rooms and the other for air conditioning and cooling railway passenger trains. Frigidaire Corp., Dayton, O., and Carrier Engineering Corp., Newark, N. J., respectively, have developed these systems.

The Frigidaire room cooler requires no attention inasmuch as the mechanism is automatic. It runs only at intervals, just long enough to keep the room at the desired temperature. One of the models is provided with a cooler which uses city water to reduce the temperature of the air before it passes through the cooling coil proper; the other is not provided with the precooler. Both, however, have an air deflector which may be moved to vary the direction of the cooled air as it leaves the top of the cabinet.

The Carrier system of air conditioning and cooling for railway passenger trains, employs steam from the engine as the refrigerating energy and water as the sole refrigerating medium, thereby eliminating gaseous refrigerants. Fig. 1 shows the new system in a passenger coach.

The elementary law of physics that water will boil or give off its heat at comparatively low temperatures when the atmospheric pressure is reduced, as in high altitudes, is the basis of the new refrigeration development. A tank partly filled with water is concealed at one end of the car. Steam drawn from the engine is forced under pressure past an opening in the upper part of the tank, thereby creating a vacum within, and causing the water in the tank to boil at the lower temperature. In boiling, the water gives off heat in the form of vapor which is drawn out of the tank by the suction of the steam, and results in reducing the temperature of the remaining water still further, to about 40 degrees. This cold water then is circulated through coils concealed in the roof of the car. Air is drawn over the cooling coils, where it is cooled and de-humidified, and thence circulated throughout the car by ducts. From the cooling coils, where it acquired heat in cooling the air, the water is returned to the tank. The portion of the water that had been vaporized passes through condensing coils and likewise is returned to the tank. The whole cycle is repeated, the system being almost completely automatic.

The fact that steam is used to refrigerate the water obviates the necessity for providing considerable extra electric power for the operation of a refrigerating machine as has been the case with previous systems. Use of the existing source of electric current on a train for operation of fans and pumps, eliminates the difficult problem of finding large additional and continuous source of power. A set of heating coils is also a part of the new system, permitting its use in the winter months to supplement existing heating facilities and provide the additional elements of humidification and ventilation. Engineers believe the new development foreshadows general application of air conditioning and cooling on American railroads.

There are now about 3250 plants in 200 industries equipped with air-conditioning, according to a recent survey made by the Copper and Brass Research association to determine market prospects for copper in this field. In addition

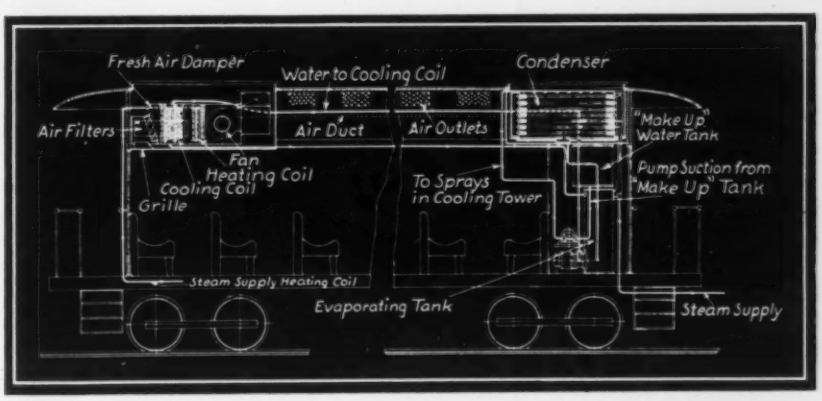


Fig. 1—Diagrammatic arrangement of a new system for air-conditioning and cooling passenger cars

to the industrial plants there are about 300 theatres, 25 large department stores, and 75 retail stores in which air cooling systems have been installed. It is estimated that at least 2500 of the 14,0000 theaters in this country are large enough to use such installations. Surely a market exists for companies considering the development of this type of equipment.

Flexibility Improves Traction

FOR transportation over rough ground there probably is no kind of traction unit better suited to the task than the crawler or track laying type. Armored tanks during the World war proved the possibilities of this design, although there since have been developments that

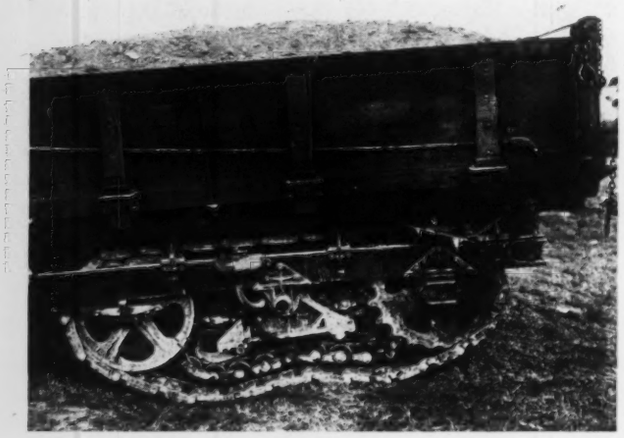


Fig. 2—Flexible traction unit conforms with contour of ground surface

add materially to the practicability of this type of unit for commercial use.

Traction units employed on the army tanks served well, even though of the rigid type. On heavy trucks in use today, however, it has been found that an element of flexibility must be considered in the design. In the traction unit developed by Linn Mfg. Corp., Morris, N. Y., this is obtained in an ingenious manner by means of a flexible roller chain assembly and two runner blocks. The flexibility as provided by this track-laying arrangement or compensating device by permitting it to take up freely on uneven surfaces, is shown in Fig. 2.

Lags connected together and driven by a double rimmed sprocket form the crawler which conforms readily to the surface of ground over which the machine is traveling. The unit so operates that the rollers always are in contact with the lags and lags with the ground. The weight of the chassis and pay load is carried directly over the traction unit. This weight first strikes the rocker beam axle, which is a dead axle on which rockerbeam is mounted. From there the load is distributed equally by the two runner blocks, through the rocker beam to the hubs of the rollers, which have flanges or rims on either end in contact with the lag bed.

Each lag and roller thus carries its share of the weight of the chassis and load, at all times compelling the track to conform to the contour of the ground with maximum traction even though the terrain over which the machine is traveling is rough. As traction is dependent upon the area of the tracks on the ground ,increasing the weight upon the tracks increases their tractive effect. The logical weight to carry over the tracks on the space left clear by Linn design is pay load. This makes it possible to eliminate all unnecessary weight in the design of the machine by carrying pay load to increase traction, thus economizing in fuel consumption and general wear and tear when the machine is running light.

Filing Cards by Electric Eye

THE list of photoelectric cell applications grows as engineers work continuously to develop new machines incorporating it in simplifying difficult and involved work which now is done by hand. One striking example of this is the introduction of a one-eyed (photoelectric cell) robot to sort millions of cards at a high rate of speed. A Westinghouse engineer, Douglass A. Young, designed this ingenious unit, shown in Fig. 3.

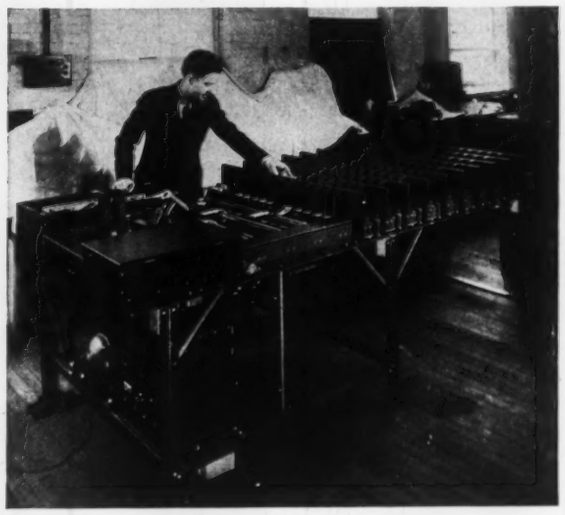


Fig. 3—Filing machine employs photoelectric cell to distribute cards

Development of this machine is the result of request from a large corporation for a device to classify the thousands of bill stubs which are returned by customers with remittances each month. Filing these by hand is a tremendous task so the research and engineering department set out to solve the problem. The electric eye was brought into play.

Operation of the robot is simple and requires the services of only one person. When the names

and addresses are stenciled on the bills, a number is printed also. This number guides the sorters in the classifying of the stub when it is returned. With the new sorting machine, this same principle is carried out, only a simple printed code is substituted for the numbers.

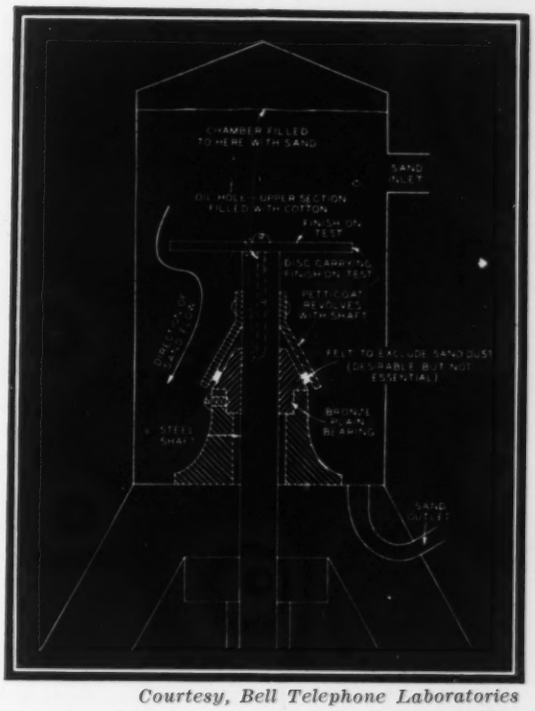
When the operator is ready to start sorting, after turning on the power, he places a stack of cards in the feeding receptacle of the machine. The lower card is picked up by an ingenious device covered by live rubber, which operates effectively even with badly mutilated cards.

The rubber covered device frees the lower card from the cards above and pushes it forward under the gaze of the "electric eye," focussed on a spot which the card must pass over before being routed to its proper place. Reading of the card by the "eye," which in turn operates the various relays, is done in the fraction of a second. The card passes under a light beam and the light is reflected by the light surface of the card and interrupted by the code lines. These signals are transmitted by the photoelectric cells to the relays and the trip switches which cause a mechanical arrangement to take the classified card to its proper place in any of the 100 compartments in the machine.

Another application of the "electric eye" is that of cutting steel bars to proper length as they leave the rolls of the mill. Bethlehem Steel Co., Lebanon, Pa. has installed equipment for this work, using a General Electric unit. As the bars are still hot when they leave the rolls, they give off enough light to actuate the device and thus cause the operation of a shear which trims the bars to correct size.

Spindle Bearing Operates in Sand

SUPPLEMENTING the description of the finish wear testing machine on page 31 of the September issue of MACHINE DESIGN, there is shown in Fig. 5 a sectional view depicting the design of the parts for rotating the specimen in sand. One of the problems which confronted designers of this unit was the installation of a bearing to run continuously immersed in abrasive material. In order to rotate with a minimum of eccentricity the specimen to be tested it was necessary to locate the shaft bearing directly beneath it.


CHAMBER FILLED TO HERE WITH SAND
SAND INLET
OIL HOLE (UPPER SECTION FILLED WITH COTTON)
FINISH ON TEST
DISC CARRYING FINISH ON TEST
PETTICOAT REVOLVES WITH SHAFT
FELT TO EXCLUDE SAND DUST (DESIRABLE BUT NOT ESSENTIAL)
BRONZE PLAIN BEARING
STEEL SHAFT
SAND OUTLET

Courtesy, Bell Telephone Laboratories

Fig. 5—Design of wear testing machine spindle to permit operation of bearing in sand

In the illustration it will be seen that the shaft is fitted with a petticoat which revolves with it. The bearing is the plain bronze type and is protected by the petticoat which extends down over it, thus shedding off the sand. A felt seal may be employed to assist in keeping the sand away from the bearing, but it is not essential. In view of the fact that the circulation of the abrasive is downward, it being taken out at the bottom and returned at the top of the chamber, there is less tendency on the part of the sand to work up into the bearing.

What Will Be Next in Aviation?

OUTSTANDING developments still are taking place in aviation. The new navy dirigible AKRON is successfully completing its trial flights;

Fig. 4 — Revolutionary design in aircraft characterizes construction of Sky Car. The all-metal plane utilizes pusher-type engine

Great Lakes Aircraft Corp., Cleveland, plans to put a high speed steam turbine powered craft to practical flying tests soon; a plane without a tail is being tested in Germany, and Stout Engineering Laboratories, Dearborn, Mich., has developed an all-metal plane for the private owner, known as the "Sky Car."

In these developments three things are outstanding. One is the application of an old form of power to the newest mode of transportation; the second is the choice of metal over wood and fabric for the smaller craft; and the third is the elimination of the fuselage.

The Sky Car shown in Fig. 4, is the idea of W. B. Stout who was the designer of the Ford transport planes. He has taken his experience with large metal planes and applied it in the construction of the smaller unit. In discussing the design of the metal wing he explains why he uses corrugated wing material: "If thin sheets are corrugated along the line of air flow, since each corrugation is a section of a tube it becomes a rib or strength member with one hundred times the compression possibilities of a flat sheet."

Extruded duralumin T-sections riveted into a cantilever truss girder are employed for the spars of this new airplane. As seen in the illustration the pilot's vision is unobstructed, there being no propeller in front since the plane is the pusher type with the 75-horsepower, air cooled, inverted type engine in the rear. A forward wheel prevents nosing over on rough or soft field, and wing tip ailerons and the propeller are protected by a steel tube outrigger. A two-place tandem seat arrangement with an enclosed cabin is embodied in the design.

Mr. Stout declares that the future of air travel depends increasingly on better materials, metals such as duralumin, magnesium and alloy steel holding an important place in this field.

Copper Core Cools Valves

DEVELOPMENT of valves and other parts for high speed engines has proceeded in two directions; first, through search for materials which are more heat resistant and, second, through improving the performance of existing metals with the use of coolants. To the latter end, the salt-sodium method, now employed extensively to cool aircraft and heavy-duty truck exhaust valves, was the only effective method until the perfection of copper cooling, which is the feature of the valve shown in Fig. 6, developed recently by Thompson Products Inc., Cleveland.

Copper cooling differs basically from other methods, as it depends on conduction rather than convection. Thermal conductivity properties of aluminum and copper are well known, and for many years efforts have been made to fill valves with these metals by drilling out the valve stem and pushing in rods of these materials. It was impossible however, to avoid air pockets; consequently, a good bond was unobtainable and conductivity was greatly diminished by this method of technical procedure.

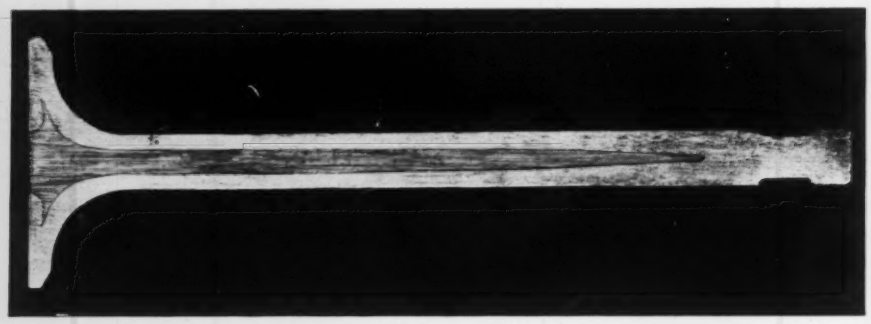


Fig. 6—Exhaust valve of alloy steel with copper core for cooling

For the new valve, engineers of the Thompson company have been able to develop a unique method of forging copper symmetrically into the valve stem and head. As shown in the accompanying illustration, copper is forced well out toward the seat of the valve, taking heat from the head, the cooling effect being governed to an extent by the shape of the section. The copper running down the stem always is exactly centered and with the exception of but a few steels, a perfect bond exists between the copper and steel after forging. In case where no bond forms, the fit is so tight that conduction is impaired little. While the heat conductivity of aluminum is slightly better than copper in the high ranges, improving as the temperature rises, that of copper remains almost constant and is much the better of the two in the low motor operating ranges.

Changes Seen in Auto Gear Box

FREE wheeling, synchromesh transmissions, and other types of continuous or automatic change gears designed to do away with the noise and inconvenience of gear shifting have caused the Society of Automotive Engineers to begin the study of motor vehicle transmissions anew. Coupled with their desire to improve American cars, activity abroad, particularly in Germany and France, has accelerated this work. Inventions are coming from all parts of the country. Two engineers from the South recently developed a new device which they claim will eliminate the present gear shift box. It is not unlikely that within the next five years additional marked improvements will be seen in transmissions.

Co-ordinating Design Activities with Company Management

By L. E. Jermy
Managing Editor, Machine Design

THROUGHOUT this series of articles dealing with the relations of the engineering department within and outside the company it has been almost impossible to discuss any phase of design in connection with sales or production activities without taking into account the role of management.

This is not surprising because the organization of a company engaged in the design, manufacture and sale of mechanical devices or equipment usually provides that engineering production and selling shall function under the direction of one or more executive officers who constitute the management. In a very small company the president may serve not only as the chief executive but also as head of one of the departments. The other extreme is a large corporation in which authority passes from the president down to the various departments through several vice presidents or through a general manager.

Regardless of the size or character of the organization the functions of management, engineering, production and sales are quite clearly defined. The chief engineer is in immediate charge of design and engineering, the works manager has direct responsibility for production and the sales manager is held accountable for selling. Over and above them is one or more executive officers who are charged not only with the supervision and co-ordination of the work of the three departments but also share the responsibility for their performance. The executive officer or officers in turn are responsible to the directors or owners of the business.

The general aspects of this division of responsibility are so well known that it may seem unnecessary to present the foregoing brief outline here. Nevertheless we find in the many letters received in connection with this series of articles abundant evidence that numerous executives, engineers, salesmen and production men do not understand or appreciate the real role of management. On one hand are certain company executives who take the attitude that they have no responsibility for engineering. On the other side are chief engineers so limited in their conception of management that they believe the chief executive should place engineering ahead of all other considerations.

Here again we have misunderstandings which are a barrier to effective co-operation. The remedy—as in all other cases under discussion in this series—lies in analyzing the points of common interest in the functions of management and engineering. To this end MACHINE DESIGN last month presented a composite letter enumerating some of the important qualities which managerial executives expect to find in engineering personnel. The other side of the question is

WHEN proper support of design activities by management is lacking, the fault lies either with the engineers for failing to win confidence or with the company executives for not appreciating the value of sound engineering service. Thus management is partly responsible for design.

On the following pages MACHINE DESIGN presents a letter in which engineers state how they think management should share this responsibility. In effect it is a reply to the chief executives' letter published in the last issue.

Next month salesmen of parts and accessories for machines will present their opinion of engineers engaged in design.

The Editors.

discussed in the accompanying letter "What the Engineering Department Expects of Management," by a group of engineers.

Our conclusions, after reading opinions from numerous representatives of both sides, is that the chief bone of contention is the apparent failure of management to place the proper valuation on engineering service. In making this declaration, we are not necessarily condemning management, although we believe it has much to answer for in its treatment of engineering problems.

Regardless of who is at fault, the situation calls for a clarifying of management's responsibility for design. What is this responsibility?

Primarily it is one of according engineerng the status which it deserves. It involves on the part of company executives a willingness to stand as staunchly behind sound engineering as it supports sound sales or production policies.

Too often management looks upon the engineering department as a consulting service—something on the order of that of the company attorney or one's personal physician. Too frequently the chief executive asks for engineering counsel and then acts arbitrarily in accepting

What the Engineering Department Expects

DURING the past few months we designers have been told of our various shortcomings rather sarcastically by "Machinery Salesman" and somewhat more sedately by a group of managerial executives. Undoubtedly a certain amount of this criticism was due us, but on the other hand we not only have something to say in our defense but also are fully justified in voicing certain well grounded complaints against our critics.

The arguments of "Machinery Salesmen" which apply

"Many executives are much more absorbed in sales and production than in engineering."

to the relations between the sales and engineering staffs were answered competently in the August issue of MACHINE DESIGN; therefore in this discussion we will confine ourselves to the problem of relations between management and the engineering department.

Of first importance is the question of authority. No one will deny that the head of the engineering department is immediately responsible for design, but there seems to be some doubt as to management's share in this responsibility. For instance, "Machine Salesman" blamed the design department for procrastination, obstinacy and numerous other sins which he claimed lost the company $2,000,000 of business. If the circumstances set forth in that now famous letter were true, then management and not the engineering department was at fault for permitting conditions whereby an order of that size could be lost.

Hundreds of cases could be cited wherein sound advice on design, offered by the engineering department, has been ignored or turned down by management. When the circumstances are such that the outside world perceives that the company has bungled an opportunity, the usual verdict is that the engineers fell down on their job. Management seldom is held accountable for its errors of commission or omission in connection with engineering.

From the engineers' standpoint the principal complaint against management lies in the failure of the company's executive officers to give adequate attention to the engineering side of the business. In the average establishment engaged in the design and manufacture of machines, the three principal departments are engineering, production and sales. The functioning of each and the co-ordination of their activities normally proceeds in accordance with a company policy, which is formulated and administered by the management, invested in the executive officers.

Our specific complaint is that too often management is unfairly partial to the sales and production departments—or conversely, is not faithful enough in its support of the engineering department. Sometimes this is due to the fact executives are more sales or production minded than engineering minded. In a few exceptional cases an internal "political" situation exists, which more often than not reacts against the engineering department. But in general the apparent discrimination against engineering is due to the fact management is unfamiliar with design and scientific matters whereas it is well versed in the business problems involved in sales and production.

A few specific instances will serve to illustrate the handicaps under which the engineering department labors in its dealings with management.

In one case, the president came into the chief engineer's office with the sales manager and one of the company's important distributors. The distributor offered the suggestion that if he were designing a certain machine (then in process of redesign) he would introduce certain innovations. Despite the fact the suggested changes had been thoroughly considered and duly abandoned as impractical, the president—in response to the earnest pleadings of the sales manager—summarily gave orders that these suggestions be incorporated in the new model. The chief engineer had no recourse but to follow instructions. He proceeded as ordered and after spending much time and money finally arrived at a point where it was evident to everybody—including the president and sales manager—that the idea was not feasible.

or rejecting it, but refuses to acknowledge responsibility for the decision.

The ideal relationship is one in which the engineering department takes its place alongside sales and production as a closely co-operating branch of the business. To accomplish this it is not necessary for management to be thoroughly posted on engineering problems, but it is highly desirable that management be capable of weighing sales, production and engineering considerations judiciously so that the latter is not discounted.

Errors by management in appraising the worth of engineering service will be lessened when the engineering department enters more fully into the councils in which company policy is formulated. In establishments where the chief engineer sits in executive conferences on an equal footing with the sales and production heads, management encounters little difficulty in evaluating engineering service equitably. It is in concerns where the chief engineer is excluded from policy councils that management falls down on its obligations to design.

The burden of realizing this ideal situation rests equally on engineers and management.

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of Management—By a Group of Engineers

Of course this is a case where the president and sales manager were courting the favor of a distributor. However, had they exhibited even the slightest confidence in the engineering department the company would have been saved a tidy sum.

In another case the general manager insisted upon incorporating a certain feature of design in a new machine despite the protests of the chief designer that the item was adequately covered by patents held by a competitor. The detail in question was embodied in the model and in due course an expensive infringement suit was fought and lost, whereupon the general manager disowned all responsibility. The president held the engineering department accountable for the disaster. Had management paid heed to the advice of its engineering staff, this bungling could not have happened.

A chief designer of a reputable company had advocated a certain improvement on every occasion when the company's product was being redesigned. Each time the general manager vetoed it, saying "It will cost too much." After about 10 years the sales manager burst into the office with the declaration that the managerially despised idea must be adopted if the company were to keep ahead of its competitor. With this endorsement the general manager ordered full speed ahead in embodying the device on current models. The works was turned upside down in the effort to adopt an idea that had been snubbed for many years. And today, except for those who have looked behind the scenes, the credit for this enterprise is accorded the sales manager and the general manager, while the chief designer is thought to have been asleep on the job.

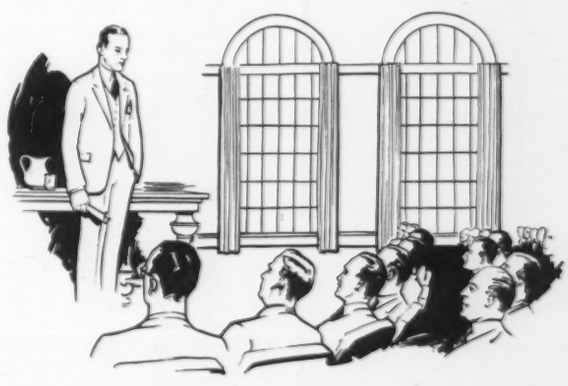
Illustrations of this kind can be cited by the thousands. They prove that too often engineering advice is ignored in favor of pressure or influence brought to bear by department heads who stand higher with management than the chief engineer.

In last month's issue a group of executives named six characteristics which they expect in engineering: Sound engineering knowledge, good "business sense," initiative, resourcefulness, adaptability and open-mindedness. Engineers generally will agree with management that these qualities are desirable and essential. However, we wonder how many company executives realize the extent to which their actions govern the ability of engineers to acquire or exercise these desired characteristics.

Take the factor "business sense." It connotes a knowledge on the part of the engineer of the commercial and competitive circumstances under which the company's product is being manufactured, sold and used. No matter how anxious the engineer may be to study field conditions, to examine competitive machines in service and to become familiar with other commercial aspects of the business, he cannot go far in this direction without the sanction and sympathetic support of management.

The average company has a liberal allowance in its sales budget for "sales promotion" or "cultivation" of prospects. Experience doubtless has proved that this expense is well justified. But is it not possible that a small allowance in the engineering budget, permitting adequate study of field conditions would prove equally beneficial?

An engineer finds that one of the best ways of keeping abreast of progress in his profession is to participate actively in one or more engineering societies. We believe management should share this view and that it should encourage engineers in this form of activity. In many companies the executives openly advocate engineering society membership and activity, but in far too many establishments permission to attend a convention of professional men is either refused or granted grudgingly. In fact we can cite instances where highly capable engineers have attended meetings on their own time and at their own expense rather than be deprived of the opportunity to keep posted on new developments in their profession.



"Often, of necessity, pays his own expenses to attend technical sessions of conventions."

Preloaded Antifriction Bearings I

Accuracy and Rigidity

THOUGH preloaded bearings have come into general use only in the past few years the first bearings of this type were produced in 1915. In their manufacture the purpose was to grind two angular contact bearings for use on worm drives, etc., so they could be clamped together, each bearing to take thrust in one direction, and the pair to divide radial load between them. To make this arrangement in pairs possible, it was necessary that the side surfaces of the inner and outer rings should be: Nearly flush with each other; parallel with each other; and parallel with the ball paths or races.

To obtain all these characteristics by holding close tolerances was considered impractical, so a new process was developed, and a special machine called a "duplex" grinder was built by Gurney Ball Bearing Co., Jamestown, N. Y., now Gurney division of Marlin-Rockwell Corp. The principle used is to grind the sides of the rings flush and parallel after the bearing is assembled. Of course, the bearing is assembled only temporarily for this operation with a few balls and no retainers; but, nevertheless, the principle is the same.

A tapered shaft with a small angle wedges a set of balls against the inside diameter and pulls the inner race back by spring pressure, Fig. 1. The outer ring then is rotated on its own ball path and the side surface *B* is ground. Then the outer race is stopped and the inner race rotated on its own ball path. The wheel is fed across the inner race in exactly the same position to grind the side surface of the inner race *C* exactly flush with the surface *B*.

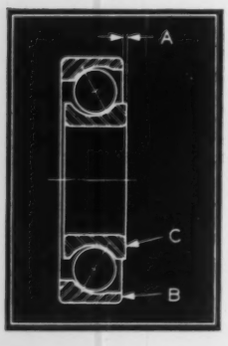


Fig. 2—Relative position of races before mounting

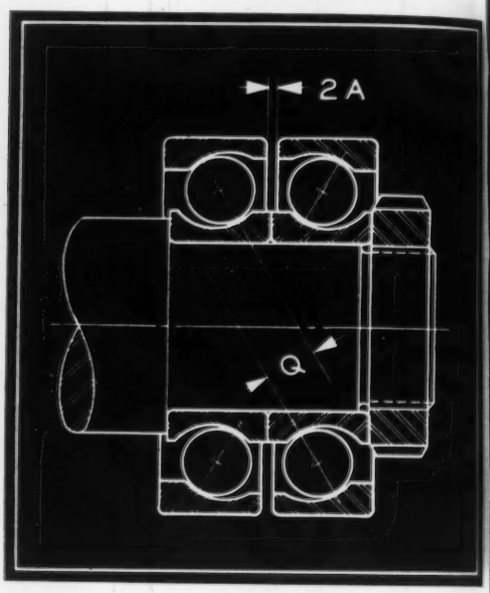


Fig. 3 — Duplex bearings mounted in pairs with inner races locked tight by a nut. In operation the outer races are clamped together

After the procedure explained above, the bearing is assembled with new balls, and the following special characteristics result:

The outer race recedes from the inner a small distance *A*, Fig. 2, equal to the endwise deflection of the bearing under the spring load used.

The side surfaces *B* and *C* are parallel with each other and parallel with the plane of the balls and ball paths to extremely close limits.

The distance *A* is almost exactly the same for all bearings of the same size.

These bearings always are used in pairs. The inners are put on the shaft and locked tight by a nut, Fig. 3. Outer races then are loose and, if held together by hand pressure, will have an opening between the outer races equal to 2*A*. When mounted for operation the two outer races are inserted in the housing and clamped tightly together, closing the space between the two outer races. This operation squeezes the balls slightly. Each bearing of the pair is squeezed

Insure Extreme

By Thomas Barish

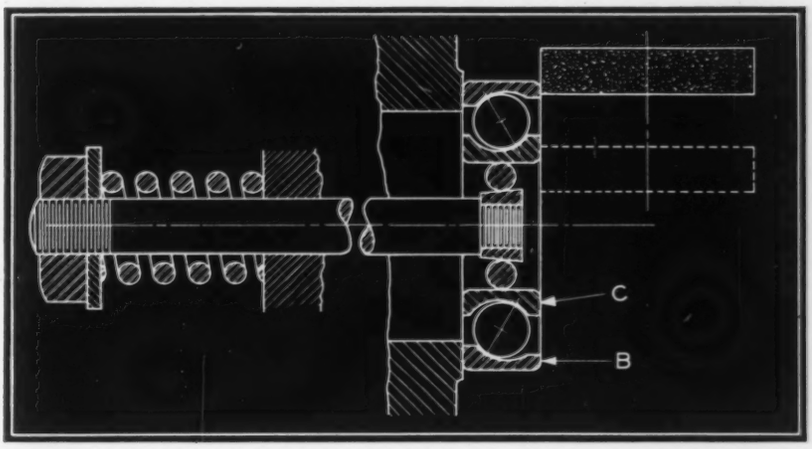


Fig. 1—Spring pressure method of preloading bearings. Races are held in position while surfaces B and C are ground

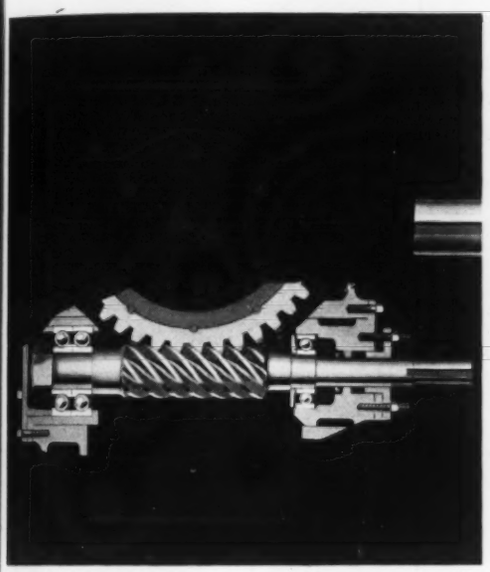


Fig. 4 — Bearings used as standard equipment on industrial worm drives take thrust in both directions and divide radial load

against the other with a thrust load exactly equal to the pressure exerted by the spring during preparation.

The bearing is particularly foolproof because the small initial preload is obtained without any adjustment on the part of the user. He need only clamp both inner races and both outer races tightly together. The amount of squeeze is determined in the grinding of the bearings and the bearings cannot be overloaded or underloaded.

The only way in which the preload can be increased above the intended value is by excessive press fits on the shaft or in the housing. This tends to expand the inner races or contract the outer races, increasing the amount of squeeze on the balls. For this reason it is necessary to be unusually careful to avoid excessive press fits, in putting these bearings on the shaft and in the housing.

If the preload has been increased too much by too large a press fit, the bearings may heat, especially at high speeds, and may fail prematurely. They can be relieved quickly by loosening up on the clamping, which permits the outer races to separate or spread and leaves a small opening between them, as in Fig. 3. This is not the best practice because it loses the desirable end clamping of the races. It is better to relieve the excessive press fit or, in emergency, place a thin shim between the outer races to spread them slightly and retain endwise clamping.

This bearing was designed originally for reversing thrust loads, particularly where there are shock loads to combat. They have been used as standard equipment on industrial worm drives for many years, and still are considered an efficient design for this type of load. Fig. 4 shows one of these units. The bearings take thrust load in both directions and divide radial load.

Careful observation of machine tool spindles incorporating these bearings shows that a slight "wearing in" or rather smoothing down of the surfaces takes place during the first 10 to 100 hours of operation. There is a corresponding slight reduction of the preload. But after that the bearings will retain their adjustment for the entire life of the spindle, provided they are kept fairly clean. Furthermore, this "wearing in" effect is not noticeable in most cases because the preload usually can have a wide variation without affecting the quality of the work.

The medium-speed and slow-speed machine tools require much more preload than the small

CONTAINING a particularly clear and interesting description of the production of preloaded bearings, the accompanying article also deals with the application of the duplex type in double thrust and high speed, precision capacities. The author is assistant chief engineer, Gurney division, Marlin—Rockwell Corp, Jamestown, N. Y.

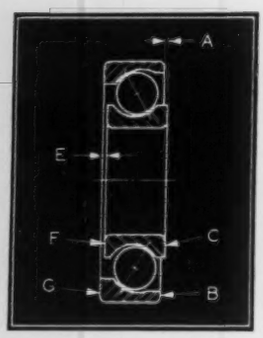


Fig. 5—In improved design, both sides of inner and outer races are ground under load

amount used regularly for worm drives, marine thrust, etc. The grinding operation is modified to produce this in the following manner: After the side surfaces *B* and *C*, Fig. 1, are ground flush, the wheel is brought back and an additional amount is ground off the side of the outer race. This additional offset of the races (Distance *A*, Fig. 2) first is determined carefully to the nearest fraction of a thousandth of an inch by a deflection test or by measuring the corresponding preload when paired.

Selecting the amount of preload to be used with ball bearings on machine tool spindles requires careful thought and experience. It should not be more than one-third to one-fourth of the rating of the bearing in order not to affect the bearing life and in order to leave a liberal margin for additional cramping due to tight press fits, slight off-square and out-of-line conditions, etc. On the other hand, the preload should be as high as possible for a maximum of rigidity, and for a margin to take care of the wearing in. If cleanliness is not ideal some lapping results and excess preload will tend to cause this also.

The bearing was improved about two years ago in one important feature, especially for use on machine tool spindles. The regular grinding operation makes surfaces *B* and *C*, Fig. 5, exactly parallel with the race grooves and with each other, and flush under a specified preload. When not loaded the races are offset by distance *A*. In the new operation each pair of races is ground to make the opposite side of the bearing fulfill the same characteristics as obtained in grinding. Surfaces *F* and *G* are made almost exactly parallel with each other and with the plane of the balls. Furthermore, and this is the important point, the offset *E* is made exactly the same as *A* for each individual bearing. The bearings then will have the following additional properties.

They can be reversed from the previous standard mounting, Fig. 3, and mounted with the high shoulders of the outer races together, Fig. 7 (shown before the nut is tightened). Clamping the shaft nut applies the predetermined preload by closing up the distance 2*A*.

Mounting the bearings in this manner increases the rigidity. The bearings offer much greater resistance to angular movements. Under a tilting or overhung load, the distance between the supporting forces is *P*. With the other mounting, Fig. 3, the distance is much less, *Q*. Hence the original design is preferred where extreme angular rigidity is not required, and where the bearings should allow for slight errors in initial alignment by allowing a slight tilting without excessive cramping of the balls, and

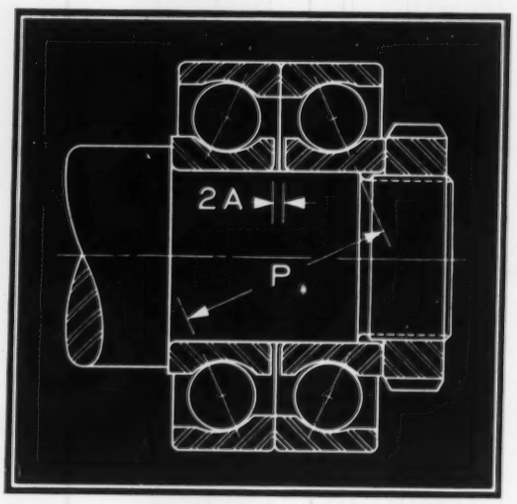


Fig. 7—Installation with bearings reversed and with high shoulders of outer races together

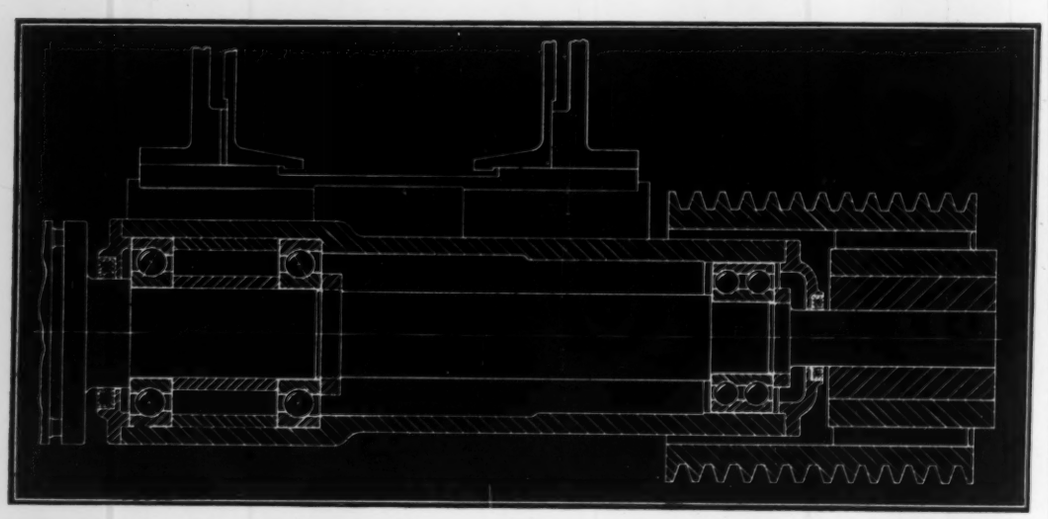


Fig. 6—Spreading the bearings materially stiffens relatively long machine tool spindles

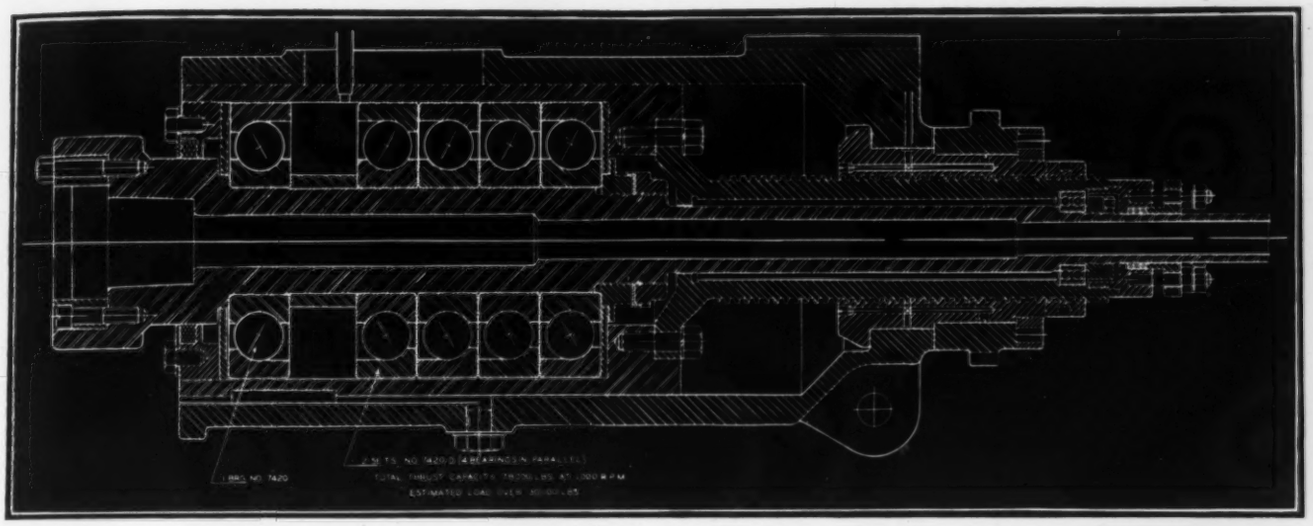


Fig. 8—Four bearings mounted in parallel divide the heavy thrust load from this piercing rod

still retaining radial and axial rigidity.

Relatively long machine tool spindles or thin spindles can be stiffened materially by spreading the duplex bearings. Spacers then are used between the inner and outer races, Fig. 6. The spacers do not need special attention for fitting. It is only necessary to make both spacers exactly the same length.

No Set Rule for Sleeve Length

The inner and outer races are clamped tightly endwise in the same way, with the sleeves also locked tightly. The sleeves should be of liberal section to prevent pounding down the end surfaces. The end surfaces should be square and parallel, or else they will spring the spindle out of line. The same is true of the nut in all cases. Heavy loads require a liberal nut with a fairly hard and square end surface. There is no arbitrary rule for the length of the sleeves. When the shaft is longer, more stiffening is required, and the bearings should be spread more. For example, Fig. 10 shows an extreme case, a long heavy duty internal grinder spindle.

The span between bearings is so long and flexible that the top bearings offer little or no support for the wheel. The duplex bearings at the wheel were spread enough so they actually support the wheel by themselves, as though the two bearings at the bottom were on a separate shaft. The top bearings likewise are spread to carry the overhung pulley by themselves. The long flexible shaft between practically serves as a flexible coupling. The design of Fig. 10 has four bearings on one shaft which must be kept in line. However, this objection is not serious if the shaft is long enough and not too stiff in the center.

Another recent improvement in preloaded bearings, especially for machine tool spindles, resulted from a careful study of the contact angle and its effect on rigidity. The conventional contact angle of the bearing was selected originally for a maximum thrust capacity and, therefore, provides the maximum axial rigidity. The large preload also adds the necessary radial rigidity. The usual contact angle of approximately 30 degrees consequently is ideal for the common machine tool spindle having large thrust loads as well as large radial loads, and requiring extreme rigidity in both directions.

However, there are a number of applications, notably the high speed bore grinders, where axial rigidity is of relatively little importance. There may be small thrust loads from the oscillation, but endwise movements (small, of course), do not affect the accuracy of the work. On the other hand, an absolute maximum of radial rigidity is desirable, even if the axial rigidity is reduced slightly. It is, therefore, desirable to modify the bearing internal design by changing the contact angle, etc.

The size of the preload, whether spring preload or positive adjustment, must be varied with the bearing design. A smaller contact angle or fewer balls calls for less preload and vice versa. Wherever possible, the preload should be determined by actual experiments on the first machine. A gradual increasing of the preload will show improved finish on the work being done even under severe operating conditions up to a certain point. A further increase of the preload will show no noticeable bettering of the finish and only tends to de-

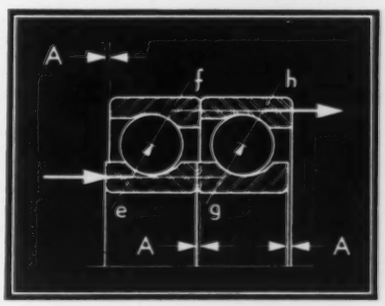


Fig. 9 — Typical mounting of preloaded bearings

Fig. 10—Four bearing mounting for heavy duty internal grinding spindle

crease the bearing life. Once the correct preload has been determined by this experiment on the first machine, it can be reproduced in production regularly without any adjustment.

The grinding method shown in Fig. 5 gives the duplex bearing a new, important property. These bearings can be mounted in parallel, as shown in Fig. 9, and the two halves of the bearing will divide shaft thrust loads almost exactly. The races will be offset by the small amount *A*, but both inner and outer races will come into contact at the same time. External thrust load will divide, part of it being transmitted along the line *EF* and part of it along the line *GH*. Indications from test are that at no time is the load on one bearing more than 5 per cent greater than half of the total load.

This property of load division makes the duplex bearing useful where the size of the bearing is limited, because of space limitation or because of extreme speed. Two or more bearings then are used in parallel to divide the total load.

This type of bearing mounted in parallel also is used in larger sizes where it is impossible to obtain enough capacity in any one bearing. Fig. 8 shows an unusual example in a tube mill. Four bearings in a row are required to carry the heavy thrust load from the piercing rod over which the tube is formed. In this case, the maximum thrust load is estimated at 30,000 pounds at 1,000 revolutions per minute. A fifth bearing at the front holds all four bearings tight and provides the necessary radial rigidity. Several of these units have given excellent performance in severe steel mill service.

Straight Shaft and Housing Necessary

Certain precautions are necessary when using several bearings in this way. Both the shaft and housing must be straight. A slight taper will permit one bearing to take more load than the others.

It should be noted that preloaded bearings expand slightly under heavy thrust loads. Heavily preloaded bearings will expand a fraction of a thousandth when the preload is applied by tightening the shaft nut. Sometimes it is better to leave the nut loose until the bearings are in place in the housing. The expansion of the outer races will make them fit better in the housing. Usually the best procedure is to clamp the inner races tightly with the shaft nut on the bench before inserting the spindle and bearings on the housing. The outer races then can be turned by hand to make sure the bearings do not bind excessively. Also, the housing fit can be checked by the ease with which the bearings go into place.

The fitting of the bearing on the shaft and in the housing is extremely important. If they are too loose, vibration or chatter may result. If the fit is too tight, the inner race will expand, or the outer race will contract, which will increase the preload on the balls and may cause early failure. A slight looseness is less dangerous than excessive tightness because looseness is offset by the expansion of the races under load, and by the positive locking of both inner and outer races.

Controlling Pipe Line Pumping Stations Automatically

TRANSPORTATION of natural gas and oils through pipe lines already has become established, and it is probable that other commodities soon will be distributed in this manner. The accompanying article covering equipment and controls necessary in oil pipe line boosting stations therefore is of timely interest. The author is president, Petroleum Electric Co., Tulsa, Okla.

By T. D. Williamson

NO BRANCH of the petroleum industry has benefited more from the work of the engineer than the pipe line department. The changes which have taken place are evidenced plainly by comparisons of pumping station design and equipment of today with that of but a few years past. Many factors which were considered somewhat of a mystery several years ago are today plain facts, as a result of investigation by the engineering profession.

Modern pumping stations are designed to be fully automatic to take care of every contingency which might arise, and not require the attention of an operator. However, it is necessary that an operator at a central point be kept informed of the operating conditions at the automatic stations, and have a certain amount of control over the starting and stopping of the pumping units. This method of control is termed the "Master Control System" and is operated automatically over a system of telephone wires.

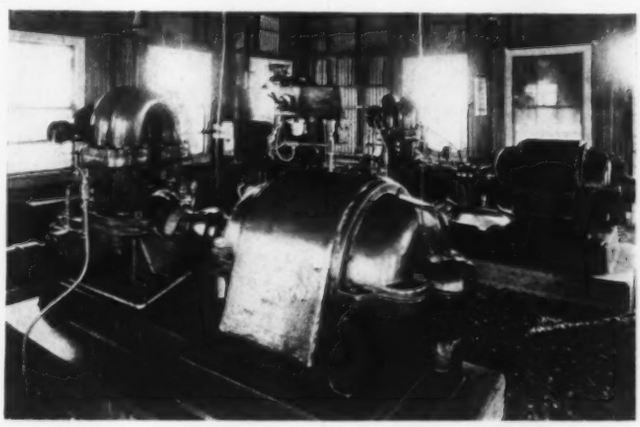


Fig. 1—Interior view of pumping station. The motors are controlled by automatic compensators

Confidence in the research results already obtained is manifest in the activities of a large pipe line company in making one of its systems fully automatic. Since this is the first commercial, fully automatic oil pipe line pumping station to be installed in the world, a detailed description of the equipment and operation might be of general interest.

Motors Are Controlled Automatically

This station is designed for a capacity of 40,000 barrels of crude oil per day, operating at a pressure of 800 pounds. Fig. 1 shows an interior view of the station, having two centrifugal pumps each driven by a 250-horsepower, 3600 revolutions per minute motor. The motors are controlled by automatic compensators, which have thermal overload protection.

The push button control stations, with indicating lights for the control of the valve motors, are installed at the top of the automatic control panel, shown in Fig. 4. Thermal protection for the bearings of each motor and pump and the stuffing box of the pump is provided in the indicating thermometers. Electric contacts are provided in these indicating thermometers, which are set at the maximum safe temperatures which these parts of the equipment may attain. The first row of thermometers is connected through flexible tubes, with the bearings of motor-pump unit 1 and the second row of instruments with those of unit 2.

The flow meter at the bottom of the panel is connected in the discharge side of the pump station and registers the amount of fluid passing through the station. Electric contacts are

provided which may be set for excessively high and excessively low flows of fluid.

In the operator's office of the central control point is located a master control board, Fig. 3. This control board is designed to show an e: act picture of the automatic station with each valve, pump, etc., in its correct relative position.

At the bottom of the panel is shown the main pipe line which runs past the station. The flow of the oil through this line is from right to left. A shunt pipe line, for the automatic station, is connected in the main pipe line at the right "Head Gate" and passes through motor valve 1, strainer, pump 1, motor valve 3, motor valve 5 and back to the main pipe line. If pump 2 is running, the fluid would pass from pump 1 through valve 2, pump 2, valve 4 and valve 5 back to the main pipe line.

Lights Indicate Operating Conditions

In the operation of this control panel, the colored lights above each equipment indicate whether the valve at the automatic station is "open" or "closed"; the motor-pump unit "stopped" or "running," etc.

In this example of the operation of the panel, it will be assumed that the automatic pump station is shut down, and that oil is being pumped past the station through the main line. The signal lights indicate all valves "closed," all motor-pump units "stop," but with electric power "on." As it is necessary to increase the volume of oil flowing through the pipe line, this automatic station is to be started. The switch under "motor-valve 1" is twisted one-quarter turn, and allowed to return to its normal position. This sends impulses over the two telephone wires and operates relays which cause motor valve 1 and motor valve 5 to open simultaneously.

When motor valve 1 opens, fluid is allowed to flow through the station pipe lines to pump 1. When the suction pressure at pressure gage *A* reaches a predetermined setting, an electric contact in the gage is closed; and when motor valves 1 and 5 are fully open motor-pump unit 1 is started automatically. Motor valve 3 is now closed, but when the discharge pressure of the pump, as indicated by pressure gage *B*, reaches a predetermined value, motor valve 3 automatically is opened slowly. When motor valve 3 is fully open, motor-pump unit 1 is operating under normal conditions. The attendant at the central control point is notified of the completion of these operations by the changing of the signal lights. Similarly for the motor valve 5.

If more fluid is to be delivered through the pipe line, motor-pump unit 2 is started by turning the control button located under motor valve 2 and the sequence of operations is similar to those described above.

By turning the control button under motor valve 1 a second time, motor valves 1 and 5 are closed, and motor-pump unit 1 stopped instantly.

If the electric power service should fail, a signal would be received at the central control point indicating "power off." Also, when the power is restored, if both motor pump units had previously been running and the attendant at the central control point had sent no signals to the contrary motor valves 3 and 4 would first close, then motor pump unit 1 would start, and motor valve 3 again open; followed by motor-pump unit 2 starting and motor valve 4 opening.

If one of the bearings in the motor or pump of unit 1 should become excessively hot, the unit would be stopped automatically (as would also motor-pump unit 2, since fluid must pass through

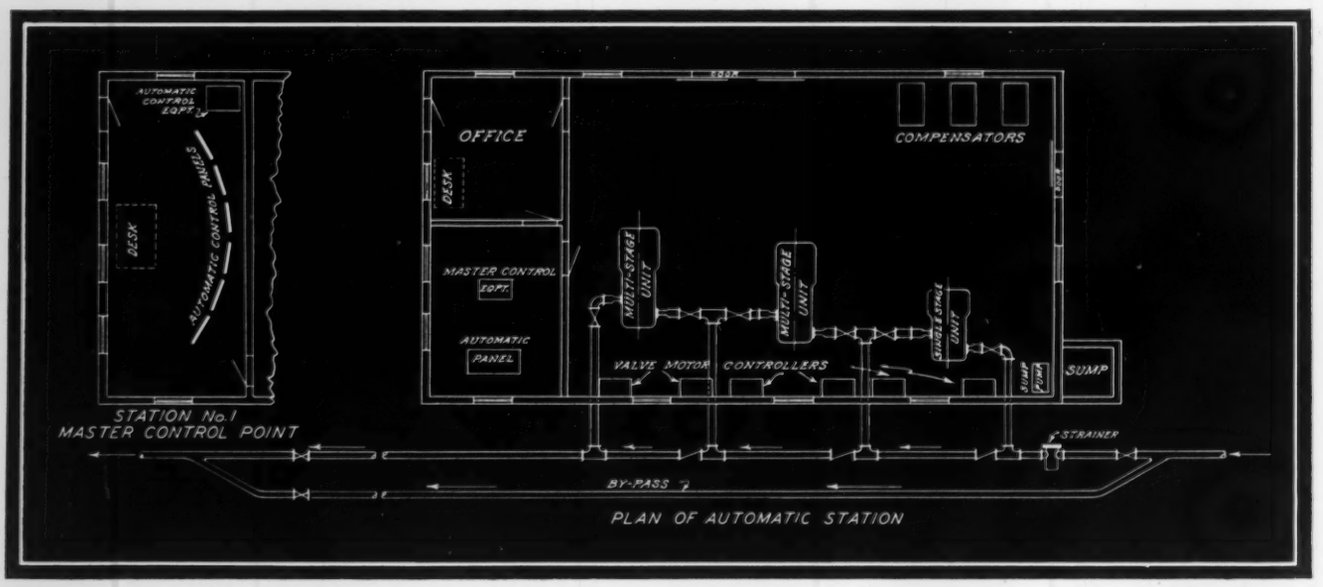


Fig. 2—Suggested arrangement of automatic pumping station, with motors, pumps, office, and control room which contains automatic and master control panels, batteries, etc.

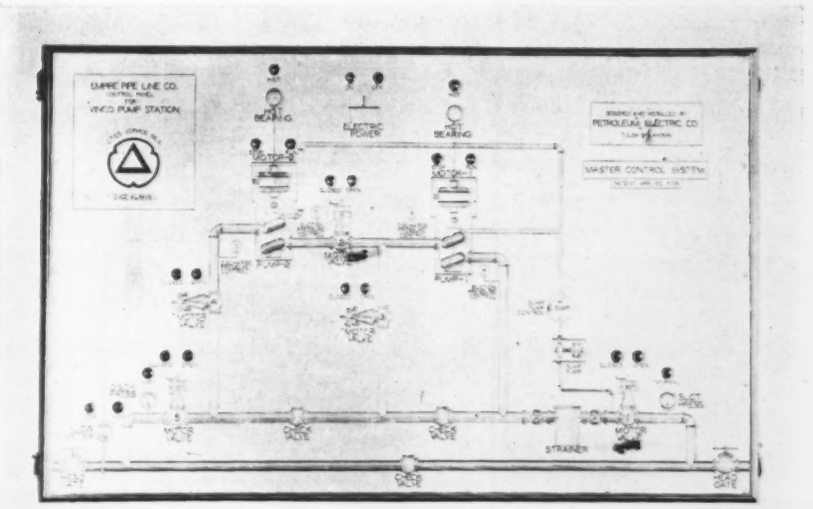
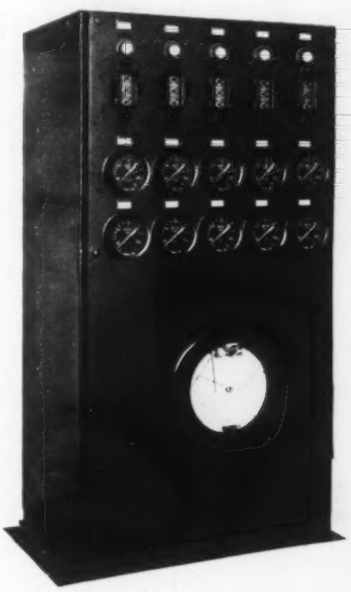


Fig. 3 (Right)—Master control board, designed to show an exact picture of the automatic station with each valve, pump, etc., in its correct relative position. Fig. 4 (Below)—Front view of automatic control panel



pump 1 before reaching pump 2). The attendant at the central control point would be notified of the cause of the stopping by the red light over "Hot Bearing" of unit 1; also that the two motor-pump units had stopped.

A broken pipe line beyond the station, causing an excess flow of fluid through the flow meter, will operate through relays to stop both motor-pump units and close all motor driven valves in the station.

Leakage oil from the pumps and other waste oil is drained into a sump outside the station. A small suction pump, motor driven, is controlled by a mercury type pressure gage to replace the oil in the pipe line. This control is so arranged that the sump pump cannot start unless motor-pump unit 1 is in operation, for otherwise there would be no outlet for this oil.

The system described in the foregoing is so designed that any number of stations may be controlled, and signals received from them, over the same telephone wires. A complete pipe line system may be controlled from one central point, regardless of its length. In Fig. 2 is shown a suggested arrangement of an automatic pumping station with motors, pumps, office and control room. The latter contains the automatic and master control panels, batteries, etc. Master control panels, similar to that shown in Fig. 3 are arranged in a semicircle, in their numerical order, in front of the attendant's desk. Thus he is able to follow the sequence of operation at each station, and is notified instantly when any contingency arises.

Exacting Requirements Imposed

Because these automatic pipe line pumping stations are designed for operation without attendants, the requirements imposed upon the equipment are more exacting than if they were to be installed in manually operated stations. Some of these requirements are as follows:

Pumps: Bearings must be of rugged construction. Stuffing box should require none or a minimum lubrication, in seepage of oil. No strainers should be required, as these, when used, must be cleaned every 24 hours. There should be no end thrust, and the impellers should be balanced perfectly.

Motors: Should be balanced perfectly to eliminate all vibration. Should be enclosed as completely as possible to prevent dust and foreign materials reaching the windings. The bearings should be constructed ruggedly, require a minimum of attention for lubrication, and be replaceable easily in case of necessity.

Motor Controls: Across-the-line type, regardless of size and voltage of the motor. Oil immersed. Extra large main contacts to prevent the necessity of frequent replacement and other attention. Thermal overload protection.

Control units in pump room: All electrical

control units, such as pressure and temperature controls, should have mercury type electric contacts. This is for safety, as gas is always present in the pump room, and they also prevent dust from collecting on the contacts which would interfere with completion of the electric circuit.

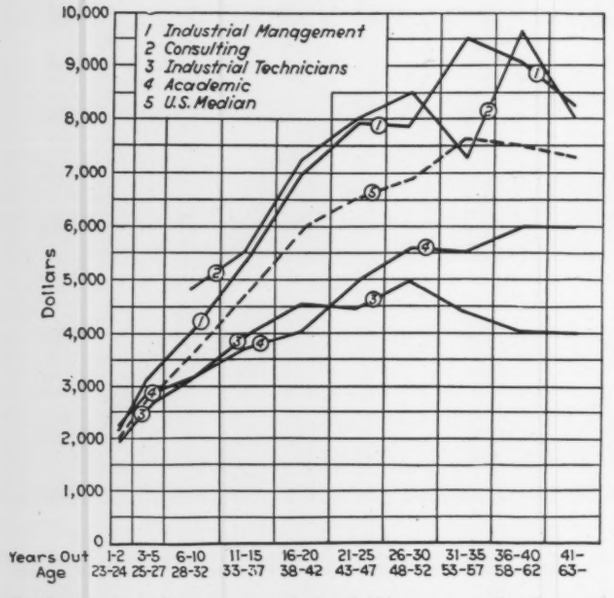
Automatic System: The control system must be designed so that every operation is performed exactly as required. There must be no failures. Relays must be selected with dependable electric contacts, and should be installed in dust tight compartments.

Master Control System: All signals, whether dispatched from the central control point or the automatic station, must be received properly, and the intended operations completed. The system must be infallible—there cannot be a failure. Such precautions are taken as providing double sets of relays, either of which would perform the proper functions.

In this day of severe competition, reduced operating costs and increased efficiency are essential to the advancement of any large organization. Because of the possibilities of accomplishing these economic results with the fully automatic pipe line pumping stations, considerable interest has been shown by executives of the large pipe line companies in the development of the automatic systems described in this article.

Managerial Ability Aids Engineers' Salaries

THAT engineering earnings do not decline seriously with age is one of the findings of a committee surveying the economic status of the engineer which recently prepared a report under the sponsorship of American Society of Mechanical Engineers, detailing the 1930 earnings of members of the profession. Throughout the report earnings are shown for groups based on years after graduation, and on comparable ages, thus bringing to light many figures and comparisons of interest to engineers.



Influence of managerial ability on salaries of mechanical engineers

If median 1930 earnings are considered as the income of the typical engineer, and it is assumed that the typical engineer marries at 26 years of age, and at 30 has two children who grow up and go to college, the balance sheet of earnings and responsibilities on the 1930 basis will be about this: He will have about $2700 to marry on; when his second child is born he will have about $3500 with which to support his wife, his two children and himself. When he is 45 and his two children are entering high school, he will have about $6500 for his family income. At 50, 28 years after he himself had graduated from college, he will have two children in college and earn about $7000 a year. If he gives each child $1000 a year for tuition and expenses, he will have $5000 left to support his wife and himself. At 60, with his children presumably self-supporting, he and his wife will have $7500 a year to spend, but must look forward to a decline in earnings to $6800 after 63.

New York Salaries Are Highest

Summarizing the results of the survey, the committee found that salaries are distinctly lowest in the Far West, and that New York Metropolitan area has much the largest percentage of high paid men above the age of 50. A good education is worth while, the report reveals, and apart from the railroads and academic institutions, the differences between industries as regards salary opportunities are not great at most ages. Regardless of whether the grouping is by technical function or by managerial and non-managerial responsibilities, the differences between managerial and consulting earnings, and all others, is so great as to suggest the importance to young men well trained in engineering, of seeking to add to their engineering abilities some capacity for dealing with people or for managing organizations or businesses. Even in the technical-operation and especially the designing fields the highest salaries are received by men whose work involves executive responsibilities.

Thrust Unit Has Numerous Design Applications

By Allen F. Clark

Editorial Representative, Machine Design

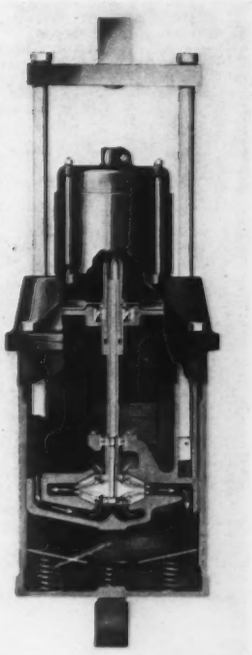


Fig. 1—Phantom view of thrustor which transforms an electric motor drive into a smooth powerful thrust

STEADILY applied force is indispensible to the operation of machinery and may be used in numerous ways. It therefore is readily understandable that applications of a device for convenient application of force can be multiplied indefinitely. Such a device, new uses for which are being discovered daily, is the recently introduced thrustor which produces a straight line, constant pressure thrust from a motor drive. Its principal fields of operation are in supplying pressure and actuating lever mechanisms, and in replacing muscular effort on foot and hand-operated machines, making them electrically controlled.

The thrustor, Fig. 1, consists of an improved hydraulic cylinder controlled by an electric motor. The rotary motion of the motor is converted hydraulically into a smooth thrust. A centrifugal impeller pumps oil from the top through to the lower side of the piston, thereby forcing the piston to rise. The splined shaft on this piston slides up through oil and through the hollow motor shaft. Intake ports admit oil to both sides of the impeller, giving quick operation and obviating the effect of impeller side thrust.

When the motor is stopped, the oil rushes back through the piston and impeller, allowing the piston to return quickly. This is accomplished usually by gravity, although the use of a spring return may be found more expedient for some applications. The operating cycle can be repeated indefinitely at a maximum of 10 to 40 times per minute, depending upon the loading and size of the equipment. Top and bottom clevises that can be pinned to either movable or fixed forks are provided.

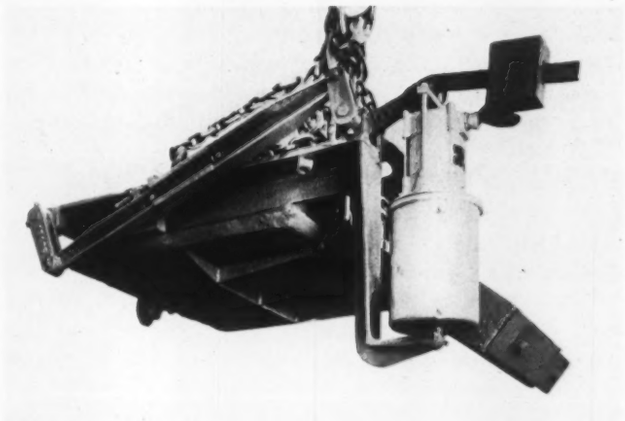


Fig. 2—Thrustor applied to hopper gates for cement, sand and gravel charges

By means of various simple lever arrangements, the upward thrust of the equipment, manufactured by General Electric Co., Schenectady, N. Y., can be transmitted into "push" or "pull" or into oblique or horizontal movements. This combination of an electric motor controlling a hydraulic cylinder offers a flexible method of doing work. The power thrust can be varied by changing the motor speed when a direct current or alternating current single-phase motor is supplied by connecting a variable rheostat in the armature circuit. Also, a time adjustment can be obtained on either the power or return stroke by controlling the oil flow through the plunger or by means of baffles.

Reduction of size, weight and current requirements of equipment, always an important consideration, is indicated in the application of the thrustor to hopper gates for cement, sand and gravel, Fig. 2, where it replaces a solenoid arrangement. Here the current saving is quite large, while the thrustor has a cushion effect in the closing of the gates, thus reducing shock and possible breakage of the equipment.

Developments in the modern trend of reducing as much as possible laborious hand operation by workmen and at the same time improving production facilities are reflected in the use of the device on the delivery table of an auto-

matic punch press. Formerly, the punched steel sheets, after they had been partially forced out by the action of the press, were grasped by an attendant, who then stacked them on the floor.

In a recent installation, the sheets, as they are forced out by the press, strike a limit switch on the discharge table. This energizes a thrustor, which, with a vertical upstroke, causes a lever to engage the punched sheet and pull it all the way cut of the press. As the sheet reaches the limit of travel, it strikes a mechanical lever stop which automatically drops the sheet on the stack below. The thrustor then resets automatically.

Spring set brakes, such as the one shown on the two-motor printing press drive, Fig. 3, can be set slowly by the use of the thrustor, reducing shocks to the equipment. Here again the device replaced a solenoid, the quick action of which introduced dangerous shocks. The upward thrust of the device is converted through levers into a horizontal push.

Fig. 4 shows a press capable of 100 to 400 stampings per minute that is operated through a clutch tripped by a thrustor. This press is used for notching segmental or circular punching of 28 to 84 inches outside diameter. The reverse of this action may be had where spring engaged clutches are used and the power stroke of the thrustor disengages them.

Not only can physical effort be reduced by the use of the equipment, but safety can be introduced. In the operation of a punch press where the usual system is the application of manpower to a lever, the upward thrust of the device is

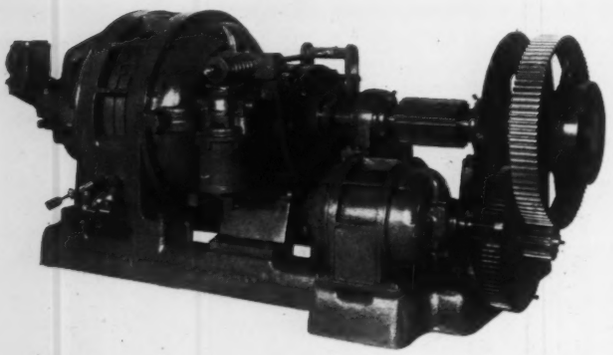


Fig. 3—Two-motor printing press drive with brake set by thrustor

used to release the brake and engage the clutch. Current is applied to the thrustor by means of push buttons installed in series. If the press is operated by one man two pushbuttons are installed and if by two men, four buttons so that the operators must push all buttons leaving their hands free of the press before operation takes place.

Valves formerly controlled manually or by a mechanical arrangement can be controlled electrically from a remote point by the incorporation in their mechanism of a thrustor. In these installations the motor cannot be overloaded. If the valve should stick or if some obstruction is placed so that the valve cannot open, the thrustor will come up as far as possible and when the valve is stalled the motor will turn the impeller harmlessly in the oil. No additional load will be imposed on the motor. In controlling the amount of opening after the first setting of the valve, indication can be made on the rheostat for any degree of opening so that it will be only necessary for the operator to select the proper position on the rheostat and the valve will open a corresponding amount. The thrustors in this capacity eliminate switches and gearing and simplify equipment needed.

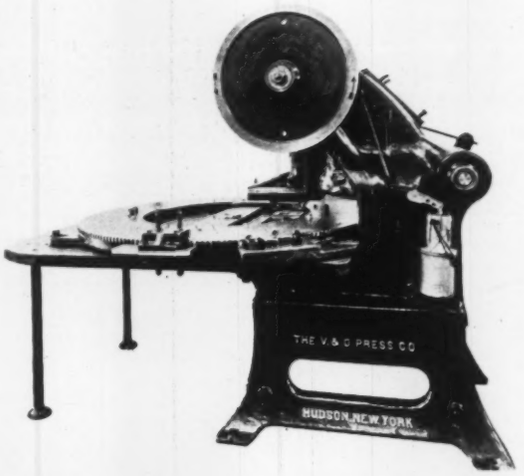


Fig. 4—Clutch on press for notching segmental punchings is tripped by a thrustor

The ability of the thrustor to operate under overload without damage to the equipment, as mentioned in the foregoing, is of unusual value. This property is also effective when there is no load on the device. If all load is removed, the piston stops at the upper end of the stroke and the impeller spins harmlessly in oil. The thrustor has been built in standard units to handle loads of from 50 to 600 pounds lift with strokes from 2 to 6 inches. It also can be furnished as special equipment for loads up to 7500 pounds maximum lift with maximum stroke of 18 inches.

It requires 0.5-second for the plunger to reach the top of a two-inch stroke after the motor is energized on the 50-pound machine (2.7 seconds on 600-pound size, 6-inch stroke) and 1.8 seconds for the return of the piston to the bottom of the stroke after the motor is de-energized (3.5 seconds on 600-pound capacity thrustor). The values for piston return are, of course, determined without the use of equipment for accelerating or decelerating the stroke.

Computing Critical Speeds of Machine Shafts

By John Flodin

WHEN it is necessary to vary the diameter of a machine shaft, the finding of the deflection, and hence of the critical speed, becomes a rather complex problem which commonly is solved by graphics.[1] It is possible, however, to devise an arithmetic counterpart to the graphical method, so that all drawing board work is avoided, and for the general run of cases the arithmetic method becomes considerably shorter than the graphical method. The procedure is explained best by means of a definite example.

Fig. 1*A* shows a shaft 70 inches long between centers of bearings having diameters of 6, 8 and 5 inches, as shown, and carrying a rotor weighing 6000 pounds. Nominally the load is distributed uniformly over the 24-inch width of the rotor, but when the shaft deflects, the load tends to become concentrated at the ends of the rotor.

No Absolute Concentration Present

There is no absolute concentration, however, partly because of the yield of the material and partly because the rotor itself tends to deflect to conform with the shaft, particularly so if the rotor is the laminated armature of a motor or generator. It is not feasible to calculate, even approximately, the locations of the centers of pressure of the two areas over which the load is distributed, but the error will be somewhat on the side of safety if it is assumed that one-half of the weight of the rotor is concentrated at a point about one-sixth of its width from each side. This gives two forces of 3000 pounds each, 16 inches apart.

From this data the reactions R_1 and R_2 may be found in the usual manner, the distances being taken from the figure:

$$R_1 = (22 + 38) \times 3000 \div 70 = 2570 \text{ pounds}$$
$$R_2 = (32 + 48) \times 3000 \div 70 = 3430 \text{ pounds}$$

[1]See Norman: *Principles of Machine Design*; and Timoshenko: *Vibration Problems in Engineering.*

The bending moments at A and at B become:

$$M_A = 32 \times 2570 = 82{,}240 \text{ inch-pounds}$$
$$M_B = 22 \times 3430 = 75{,}460 \text{ inch-pounds}$$

In Fig. 1*B* the bending moments are given by the broken line $R_1A'B'R_2$, which it is well to sketch in, but which need not be drawn to scale.

Quotient Must Be Determined

Since the deflection is inversely proportional to the moment of inertia, it becomes necessary to divide the bending moment by the moment of inertia. But in this case the moment of inertia varies, and the quotient M/I for the various parts of the shaft must be determined. Thus the left end of the shaft, which has a diameter of 6 inches and a moment of inertia of 63.37 inches^4 will be treated separately from the middle portion, which has a diameter of 8 inches and a moment in inertia of 201.06 inches^4.

As shown by the moment diagram, Fig. 1*B*, the bending moment increases uniformly from zero at the left-hand reaction to a maximum of 82,240 inch-pounds at A, but only through the length of the triangle marked (1) in the figure does the smaller shaft diameter prevail. From similar triangles the height of triangle (1) is found to be $M_C = 82{,}240 \times 23/42 = 59{,}100$, which gives the bending moment at the point where the shaft diameter changes from 6 inches to 8 inches. The mean height of the triangle (1), or the average bending moment over the 6-inch shaft, is one-half this amount, or 29,550 inch-pounds. Multiplying this quantity by the base of the triangle gives an area moment, $29{,}550 \times 23 = 679{,}650$ inch-pounds$\times$inches. This area moment must be regarded as acting at the center of gravity of the triangle, or $2/3 \times 23 = 15.33$ inches from the reaction R_1.

By like reasoning the area moment for (2) is found to be 636,030 inch-pounds$\times$inches, and so on, the various products, together with the locations of the centers of gravity of the corresponding figures, being given at the bottom of Fig. 1*B*.

The next step is to divide each area moment

by the corresponding moment of inertia of the shaft, giving the $(M\times1)/I$ quantities 10,700, 3200, etc., also shown in the figure. These quantities are analogous to forces, the point of application of each of them being through the center of gravity of the respective area, and when treated as loads on the beam they will yield deflection reactions, which are analogous to the ordinary beam reactions and are found in identically the same manner. Further, from the deflection reactions and the $(M\times1)/I$ quantities we now may find the deflection moments, which are analogous to the ordinary bending moments and are found in a manner identically similar to that used in finding the bending moments. The deflection reactions are given in Fig. 1*C* as DR_1 =15,726 at the left, and DR_2=20,773 at the right. This figure also gives a diagram of the deflection moments, which again need not be drawn to scale.

Dividing the deflection moments by the modulus of elasticity, which is here taken as 30,000,000, gives the corresponding deflections, which are given at the bottom of the figure.

Curve Gives Actual Deflection

The actual deflection of the shaft is given more nearly correctly by a curve inscribed in the rectilinear deflection-moment graph, the scale for the deflection at any point being the scale for the deflection moment divided by E. The actual maximum deflection in this case therefore would be somewhat less than 0.0109-inch shown in the figure, but the weight of the shaft itself has been neglected in this work, so that it probably is more nearly correct to accept the quantity 0.0109-inch as the maximum deflection that will occur under the conditions of this problem.

If the purpose of finding the deflection is to provide a means for determining the critical speed, and if accuracy is desired, it may be preferable to include the weight of the shaft in calculating the deflection. In doing this, it is well to break up the shaft into a number of reasonably small parts and to assume that the weight of each part is applied, as a concentrated load, at the corresponding center of gravity. In the example some time may be saved, with virtually no loss of accuracy, if the 8-inch central portion of the shaft is divided so that 14 inches of this length will be assumed to go with the 3000 pounds applied at B, while 17 inches goes with the left half of the superimposed load. The total loads thus would be about 3200 and 3240 pounds, respectively. If the weights of the thinner end portions of the shaft are assumed to be concentrated at the centers of gravity of the portions of the shaft, then the bending moments will be slightly larger, and the deflections, therefore, also will be slightly larger than the correct values.

If the deflections should be greater or less than desired, the shaft diameters may be adjusted to give any predetermined deflection by changing the moments of inertia, provided the ratio of the moments of inertia is kept the same (in this case 63.37:201.06:30.68). Thus if the moments of inertia are doubled, the deflections will be only one-half as great. It should be remembered in this connection that the moment of inertia varies as the fourth power of the diameter.

In this example the shaft has been shown

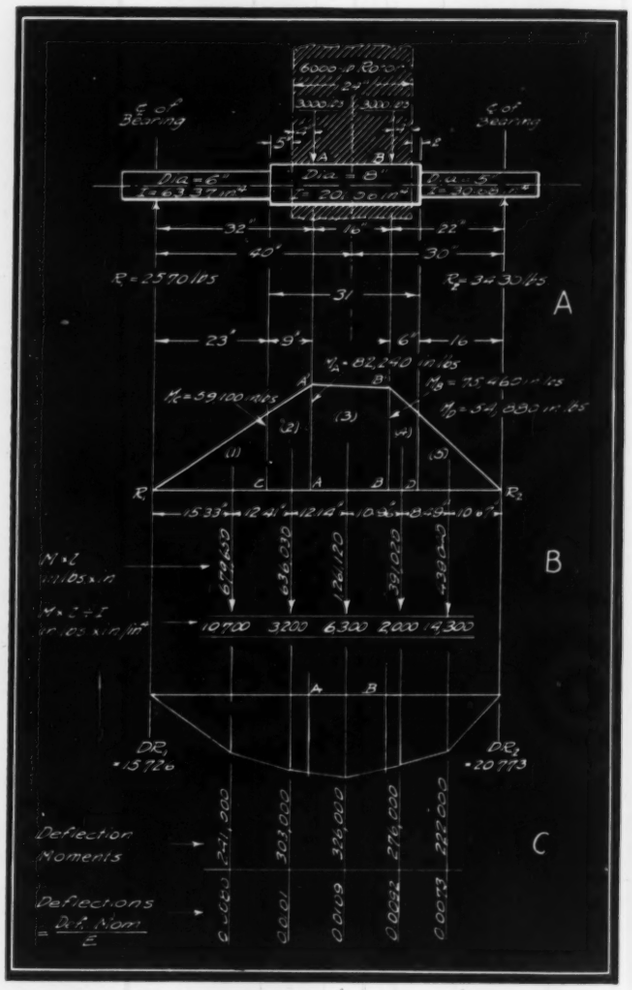


Fig. 1-A (Top)—Shaft of varying diameter used for computations. B (Center)—Bending moment graph of shaft shown in A. C (Bottom)—Deflection moment graph of shaft shown in A

shouldered at the points where the diameters change, but in practice it is preferable to have, wherever possible, a fairly long taper from one diameter to the next, especially where the difference is large. Even when generous fillets are used, shouldering produces a concentration of stress where the smaller shaft merges into the larger.[2] Where the taper is long, it may be desirable to use an intermediate step in calcu-

[2]See L. S. Jacobsen: *Torsional-Stress Concentrations in Shafts of Circular Cross Sections and Variable Diameter*, A. S. M. E., 1925.

lating the deflections. For instance, if the shaft were tapered from the 8-inch diameter to the 6-inch diameter at the left through a distance of 10 inches, it would be more nearly correct to consider the 10-inch length as having a uniform moment of inertia of 132.2 inches^4 (=201.06+63.37÷2), and to let it form the base of a bending moment area of its own, than to include this length either with the larger or with the smaller shaft diameter.

The calculations for this example have been made with considerably greater care than ordinarily is necessary in practice. It would, for instance, make little difference in the final result if the $M \times 1/I$ quantity for area (3) had been taken as acting through the midlength of the base of that area, rather than through its center of gravity; and for areas (2) and (4) might have been located by inspection with perhaps quite sufficient accuracy, thus eliminating the labor of a nonessential calculation.

Present Critical Speeds

For the general case, where the shaft is loaded with n rotors of weights W_1, W_2, W_3, . . . W_n, and where the shafts deflections at the points of application of weights are y_1, y_2, y_3, . . . y_n, the critical speed is given by

$$W_{cr} = \frac{30}{\pi}\sqrt{\frac{g[W_1Y_1 + W_2Y_2 + W_3Y_3 + \cdots + W_nY_n]}{W_1Y_1^2 + W_2Y_2^2 + W_3Y_3^2 + \cdots + W_nY_n^2}}$$

where W_{cr} is revolutions per minute, and g is the gravity constant.

If the shaft carries only one load, and if that load can be assumed to be concentrated at one point of application, the formula becomes

$$W_{cr} = \frac{30}{\pi}\sqrt{\frac{g}{y}}$$

The general formula applies in the case under discussion, but before it can be used, the deflections at the points of application of the loads must be found. This can be done easily by the direct ratio method, since the deflections at definite points at both sides of each load are already known.

The deflections in line with the partial loads become 0.0104-inch at the left, and 0.0096-inch at the right load, from which the critical speed is found:

$$W_{cr} = \frac{30}{\pi}\sqrt{\frac{32.2 \times 2\,(0.0104 \times 3000 + 0.0096 \times 3000)}{(0.0104)^2\,3000 + (0.0096)^2\,3000}}$$
$$= \frac{30}{\pi}\,196.5 = 1875 \text{ r.p.m.}$$

With long rotors, where the manner of breaking up the load and where the locations of the points of application of the partial loads are to a large extent a matter of judgment, the critical speeds found are necessarily only approximately correct. For this reason it is well to avoid operating speeds within a range of about 2 per cent, or even 5 per cent, of the calculated critical speed. Further, the critical speed also is affected by the length and kind of bearings used, by the design of the machine frame, and even to some slight extent by such elusive considerations as the character of the lubricant at the operating temperature of the bearings.

Since the shaft deflection is inversely proportional to the moment of inertia, it is clear that the deflection will vary for different angular positions of the shaft, if the moment of inertia varies for different axes at the same location. Thus a single keyway, or two keyways no matter how they are placed provided they are in the same transverse plane, will cause the moment of inertia about the axis at right angles to the plane of deflection to vary as the shaft rotates, which, especially if the keyway is long, introduces a source of vibration which may be troublesome. The obvious remedy is to use three keyways spaced 120 degrees apart, or four keyways spaced 90 degrees apart, either arrangement giving the same moment of inertia about all axes through the center of the shaft. When this is done, and when the keyways are long, the net moment of inertia should be used in finding the shaft deflections, not the moment of inertia corresponding, for the outside diameter of the shaft.

Employ Unique Fabrication Method

TWO long strips of 1/20-inch thick steels, welded together around the edges and then "blown-up" by air pressure is the ingenious method now being employed to make transformer radiators. In the manufacture by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., a pair of flat steel sheets cut to the right shape are placed back to back and welded air tight around the rim, and then spot welded down the center for strength before being deformed in any way. This flat airtight metal bag then is placed between the retaining walls of a jig, and 90 pounds per square inch air pressure (corresponding to 500 per cent normal working pressure) inflates the steel shell to produce a light, rugged, cooling section. The accompanying illustration shows a group of the assembled cooling sections after they have been inflated. After welding, inflating and forming, several cooling sections are grouped into a common header in this way to form the radiator. Automatic resistance seam welders are used for fabrication.

Engineers Should Seize Opportunities of Making Sales Contacts

A RECENT development in the machinery building industries proves again that there is some truth in the old adage, "It's an ill wind that blows nobody good." We refer to the growing tendency among manufacturers to send members of their engineering staffs on missions of sales or sales promotion character.

On a visit to a company employing a large number of engineers it was found that all but a few of them were out on the road calling on prospects. In another establishment the chief engineer and one of his assistants were reported absent on an extended trip "calling on the trade." At another plant two of the men in the design department were said to be out making calls with salesmen. A number of similar instances have been called to our attention, indicating that the practice is somewhat general.

Probably this invasion of the field by engineers is a result of the depression, nevertheless it is one of the best things that could happen to many members of the design profession.

In saying this we harbor no illusions as to the success of engineers in the role of salesmen. Direct sales by engineers probably will be extremely disappointing. But the indirect assistance which technical men can render to salesmen and the experience gained by designers in rubbing shoulders with customers and prospective customers ought to be worth much to the company.

Masters of Design!

HOMAGE is due those old-time engineers and scientists credited with the development of mechanical principles, movements, theories and elements of machines. Upon their work and the concepts inherited from them exists the basis for design of most of the machinery of modern times.

Generally speaking these men, the forerunners of our present day designers, led glorious and inspiring lives. Breadth of vision and activity created for them an atmosphere conducive to the formulation of engineering data destined to be of high and permanent value. As an example, the fifteenth century engineer and artist depicted on the following page is eminent among those who contributed to the engineering principles and ideas later employed in common practice.

For this reason MACHINE DESIGN has selected Leonardo as the fitting subject of the first of a series of illustrations of "Master Designers" to be published in this and subsequent concurrent issues.

Leonardo da Vinci

Master Designers

Leonardo da Vinci

LEONARDO the Florentine! By this simple yet impressive title one of the greatest artists of history, who also holds a commanding place among the founders of the science of applied mechanics, was known to his contemporaries. No study of mechanical development can be complete unless it includes the achievements of this versatile genius, born near the little village of Vinci, Italy, in 1452, who was at once a writer, painter, sculptor, physician, philosopher, musician, architect and engineer. No period of his life is given over wholly to any single type of activity; his greatest achievements in the fields of art and science were simultaneous.

THIS creator of the ineffable beauty of the *Mona Lisa* was also the designer of war machinery that was the most destructive of the times. Among the many basic ideas and designs evolved by Leonardo are:

Flying machines	Breech-loading cannon	Antifriction roller bearing
Centrifugal pump	Hydraulic press	Rolls for use in coining
Dredge; two types	Universal joint	Studies of the printing press
Power loom	Improvement on drills	Needle polishing machine
Rifled firearms	Turret windmill	Clock work driven fan

THE characteristic hopes of the inventor are expressed in the design of the needle polishing machine which was to bring wealth, and the creation of the flying machine that was "to fill the world with its great fame." Leonardo's insatiable curiosity and his exactness for detail are reflected in all his work. He broke away from mere empiricism to concepts of applied mechanics, such as the formulation of the principle of statical moments, and from this the wheel and axle, capable of widespread application. And his outstanding achievements, based principally on the creation of new ideas, exerted a direct influence on design for generations.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Timesavers Aid Busy Designers

To the Editors:

CONSIDERABLE time and much calculation can be saved by the use of the nomographic charts shown on Page 54. Furthermore, it is seldom possible to find the exact conditions to be met in the usual tables as you can with the charts, because the tables are calculated in multiples of some base figure and cannot include the infinite values between the base figures due to space considerations.

While both of these charts are original, I believe that Fig. 1, the tensile strength of bolts, is entirely new. It covers the load or stress and the tensile strength for both coarse and fine threads. The range of tensile strength from 1000 to 200,000 pounds will include practically all materials used in mechanical engineering, while the range in sizes from ¼ to 1½ inches diameter will take care of most of the common applications.

Fig. 2 is based on tables that covered three book pages and yet were not as complete as the chart. The chart is not difficult to interpret. To find the correct size of shaft to transmit a required horsepower when the speed is known, a line should be drawn through the values found on the R. P. M. and H. P. scales and extended to the Diameter scale. The diameter may be read directly from this scale. Formulas used in the preparation of this chart are: Machine parts —H. P.$=D^3\times$R. P. M.$\div 50$; line shafting—H. P. $=D^3\times$R. P. M.$\div 75$; and heavy duty shafts—H. P.$=D^3\times$R. P. M.$\div 100$.

—KARL A. ECKHARDT,
Cleveland.

Allocating Engineering Costs

To the Editor:

THE American business man is at last beginning to think. With the type of thought exemplified by H. L. Lackman in the September issue of MACHINE DESIGN the depression soon will be "licked."

Contempt for costs, distaste for systematic economy of money and materials, is a conspicuous trait in Americans, a sort of recklessness that must be a direct inheritance from the pioneers. It is, in its way, magnificent, but very poor business and, in my opinion, one of the most direct of the causes of the present economic conditions. We all knew that sooner or later we would have to outlive this condition, and comments such as Mr. Lackman's indicate that we are outliving it. We are much like the farmer who stands around and bewails the hard times while he has costly farm machinery lying uncovered to the rain where it becomes prey to rust and ruin.

Let us have more inquiries into the cost problem and uncover the proper values for our costs. This in turn will tell us what our proper selling prices should be. Then we will know just what the true profits are and not have to base business on theoretical ones. When this is accomplished it is my belief that business will be much brighter.

—CHARLES R. WHITEHOUSE,
Boston.

Designing Bolts for Shock Loads

To the Editor:

THE article by J. I. Clower on "Designing Bolts for Shock Loads," published in the September issue of MACHINE DESIGN, might well be extended. The formula

$$p = \frac{2W}{A}\left(\frac{h}{d} + 1\right) \qquad \text{.....(1)}$$

in not very convenient for use in design because the deflection, d, is caused by the impact load, P, and not by the static load, W, which is known. Hence it is necessary to determine P from W and this cannot be done without knowing d. This difficulty may be overcome by expressing p in

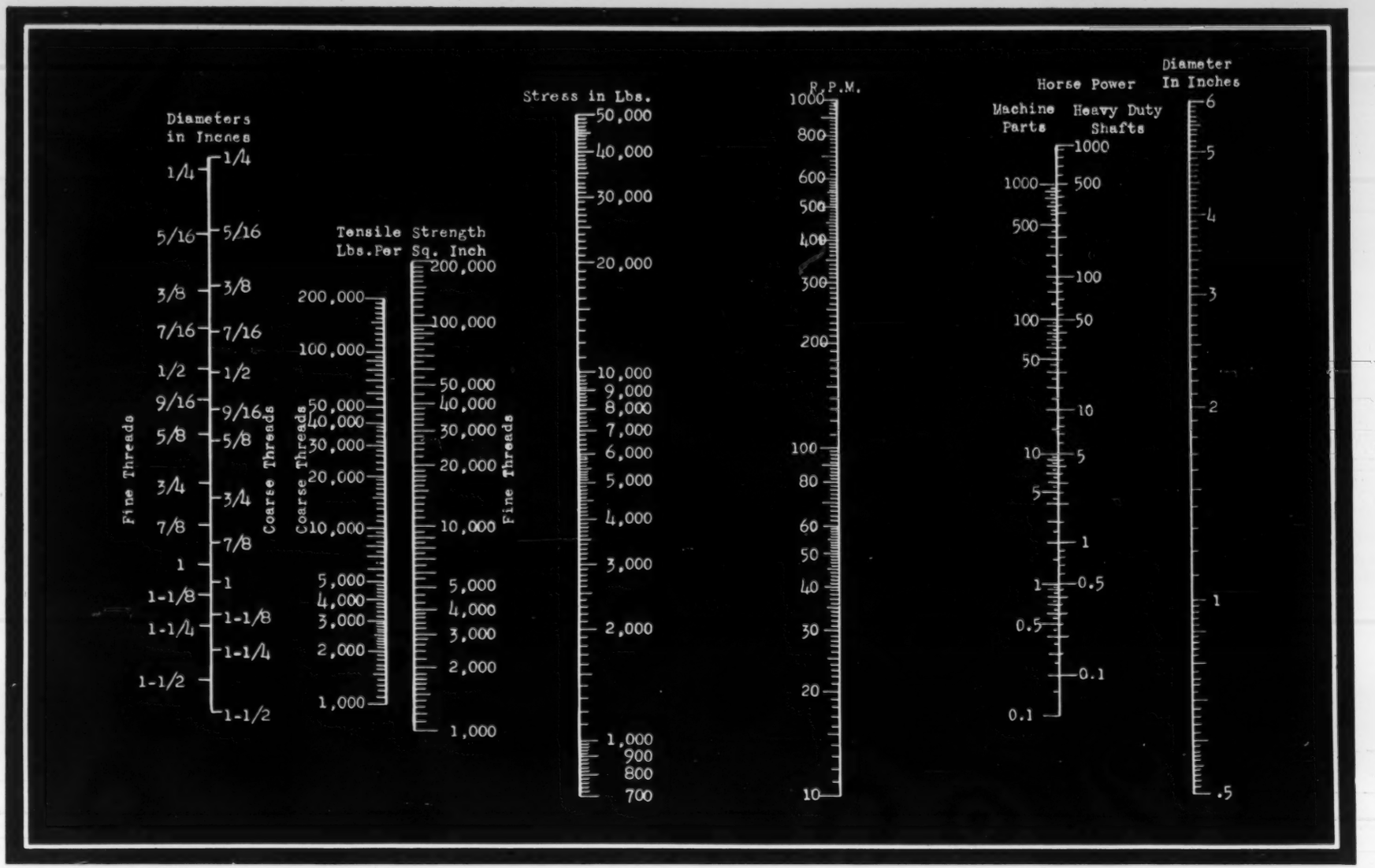


Fig. 1 (Left)—Tensile strength of bolts with American coarse and fine threads. Based on area at basic minor diameter. See page 53. Fig. 2 (Right)—Horsepower of shafting. Data for machine parts also may be used for countershafting and any light duty applications in which the bearings are reasonably close to the pulleys or gears. Data for heavy duty shafts may be used for prime movers, head shafts and other heavy duty applications. Bearings must not be over 8 feet from center to center. This chart may be used for line shafting by taking 2/3 of the horsepower as found in the column headed "Machine Parts."

terms of P instead of W. As long as loading is within the elastic limit

$$\frac{P}{W} = \frac{d}{\delta}$$

where δ is the deformation due to W. Then substituting $\delta P/W$ for d in (1) and solving for p we obtain

$$p = \frac{W}{A}\left(1 + \sqrt{2\,\frac{h}{\delta} + 1}\right) \qquad \text{.....(2)}$$

Now, if W and A are known, we readily can find δ and solve directly for the stress.

Care must be exercised in determining the deflection, either d or δ, because the stress, and hence the unit deformation, is different at points of different cross section. Consider, for instance, a rod made up of a long threaded section on each end and sections of several diameters between. The total elongation under a tensile load would be the sum of the individual elongations of each section, each section having a unit elongation corresponding to its mean stress. The maximum stress occurs, of course, at the minimum area. A section of screw threads would elongate according to the mean stress but would be stressed most highly at the root area.

Formulas (1) and (2) are the most convenient to use: Formula (1) when designing for a definite allowable stress with known W; and formula (2) when solving for the induced stress with a known W, h, and A.

These formulas may be applied to beams in bending, also, if the deflection is secured from the proper beam deflection relations.

—E. S. AULT,
Cleveland

Stresses For Heat-Treated Gears

THERE has been little satisfactory information in the technical press on the subject of allowable static stress for heat treated gears, although the Society of Automotive Engineers has compiled full steel specifications and given comprehensive data for the heat treatment of these steels for various purposes.

Heat treating is still, despite our modern control of the furnace temperature and times, a more or less doubtful process, and consequently it is yet difficult to formulate the maximum values which can be used consistently.

Conservative values, however, may be allowed as follows:

Straight low carbon steels are taken care of by the Lewis formula with its unit static stress value of 20,000 pounds.

S.A.E. 1020 low carbon steel, casehardened, can carry a unit static stress of 25,000 pounds per square inch, to 27,500 pounds.

This would assume a refined core and case tempered so as to be tough without being too brittle.

S.A.E. 2320. This 3½ per cent nickel steel has greater normal toughness and retains this quality after proper casehardening treatment. Consequently the treated gears can carry without breakage unit static stresses of 35,000 to 40,000 pounds square inch (and perhaps as high as 45,000 pounds.)

S.A.E. 3120. This steel is very similar under test to the 3½ per cent nickel steel, with great natural toughness, which is retained after casehardening and suitable tempering. The same unit stress of 35,000 to 40,000 pounds may be used for the steel.

A fair value of scheroscope reading for the case is about 90.

These stresses probably could be increased to higher values if care were used in making proper allowance for the various factors of service as is done by many designers. For general use, however, the values given should not be exceeded.

It might be mentioned that the steels referred to, casehardened, should be used for constant mesh service only, and not for clash gear service, on account of the tendency to chip off, exposing the core, and ruining bearings. For this duty higher carbon steels tempered are more suitable.

The Lewis formula is, of course, essentially for strength design, making allowance for tooth shape (the basic element of the formula) and the speed of running. It does not consider the mathematical contact; shocks due to incorrect mounting and back lash; and particularly is it lacking in a consideration of wear, which is responsible for the majority of failures. The casehardened gear is, of course, much superior to the soft steel in the direction of wear, even at the higher stress values allowed.

In the question of design to cover all factors such as accuracy, strength and wear, it is gratifying to learn that this matter is being dealt with in a technical way, and a paper by Professor Earle Buckingham before the American Gear Manufacturers association this summer is a genuine step forward in the design of gearing.

—GEORGE H. MIDDLETON,
Danbury, Conn.

In the article on "Meeting Modern Conditions in New Gearing Formulas," in the August issue of MACHINE DESIGN, it was stated that the B & S system had a 14½ degree angle of pressure (actually 14 degrees 28 minutes 39 seconds, or $\sin^{-1}\frac{1}{4}$). Advices from the Brown & Sharpe Co. indicate that this angle is exactly 14 degrees 30 minutes rather than the given value which is used in numerous treatises on gearing.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

PIONEERING in the development of arc welding, Eric Harold Ewertz has been an outstanding exponent in the art. He first successfully demonstrated its practicability in 1912. In recognition of his work the Samuel Wylie Miller medal has been awarded to him by the American Welding society.

Born in Sweden, Mr. Ewertz came to this country at the age of 20, a graduate mechanical engineer. Prior to his immigration, however, he worked in the foundry and machine shop of the navy yard in Sweden and also in the drafting and designing department of Schwatzkoph Mashine Fabrik, Berlin, Germany. One of his early positions in the United States was that of draftsman on sugar machinery, later performing similar work on machinery for Gardner & Cox, yacht designers, New York.

Mr. Ewertz rose rapidly in the engineering profession. During the World war he was actively engaged in ship construction and in December, 1918, took charge as general manager of the Moore plant of Bethlehem Shipbuilding Corp., Elizabeth, N. J. Here, in addition to ship construction, he developed machinery for oil refineries, ship deck machinery, all types of pumps, steam turbines, diesel engines, oil burning equipment, etc. In 1928 he resigned to take up his consulting welding engineering practice in New York.

YOUNGEST director of Western Electric company's board, David Levinger holds the important post of engineer of manufacture, supervising a large force of trained engineers and scientists. His recent election as a member of the board of directors marks 21 years of service with the organization.

Mr. Levinger was born in Delta, Idaho, 44 years ago and attended public school in Chicago. At 20 he was employed with the International Harvester Co., and attended night school. Later he studied mechanical engineering at Chicago Technical college. In 1910, after three years with the International Harvester company, he entered the employ of the Western Electric company as a mechanical engineer. His engineering and executive ability was recognized quickly and he progressed through supervisory positions, becoming engineer of manufacture in 1927.

His position places him in charge of 3000 employes consisting mainly of engineers and scientists engaged in the work of developing manufacturing methods and equipment. Many types of automatic and semiautomatic equipment for machining, assembling, and testing products have been developed under his guidance. Developments made under Mr. Levinger's direction, both in machinery and methods, have been so fundamental in character that they have had far reaching results in industries outside the field of telephone manufacture.

In addition to his activities in Western Electric company, he holds membership in a number of engineering and scientific societies and serves on many of their committees.

DUE to the close relation between metallurgy and design of machinery, developments revealed at the recent national metal congress in Boston, were watched closely by enterprising designers. This interest was concentrated particularly on the Campbell memorial lecture which this year was given to Dr. C. H. Herty Jr., supervising chemist in charge of the metallurgical section, United States bureau of mines experiment station, Pittsburgh. His present work deals with nonmetallic inclusions in steel.

Dr. Herty was graduated from the University of North Carolina in 1918. Three years later he received a master's degree in chemical engineering from Massachusetts Institute of Technology. In 1924 he was graduated with the degree of doctor of science by the same institution.

His presentation on Sept. 23 marked the sixth annual William deMille Campbell lecture of the American Society for Steel Treating, the first one having been delivered in 1926 by Wilhelm M. Guertler, associated with the Metall-Institut der Technischen Hochschule in Berlin.

FOR more than ten years Harry T. Woolson has been a member of Society of Automotive Engineers, first becoming active when he served on the transmission division of the standards committee in 1926. Subsequently he served on the

Leaders in Design, Engineering and Research

ERIC H. EWERTZ

DAVID LEVINGER

C. H. HERTY JR.

HARRY T. WOOLSON

meetings committee, in the parts and fittings division, became vice president representing marine engineering in 1928, and in 1930 and 1931 has served on the research committee for which he is particularly fitted, and now the 1932 nominations of the society include his name for councilor. He is chief engineer of Chrysler Corp., Detroit.

Mr. Woolson, a native of Passaic, N. J., graduated from Stevens Institute of Technology in 1897 with a degree in mechanical engineering. His engineering experience has been thorough and his rise continuous. Included among his connections are Gas Engine & Power Co. and C. L. Seabury Co. Consolidated, Morris Heights, N. Y., where he was designer until 1909; Packard Motor Car Co., of which he was truck engineer; Studebaker Corp. as mechanical engineer for five years; Willys Corp., Elizabeth, N. J. as research engineer; designing engineer in the Zeder-Skeleton-Breer Engineering Co., Detroit; chief engineer of Maxwell Motor Corp., in 1925, which position he has held with Chrysler Corp. since its organization.

* * *

A. H. d'Arcambal, sales manager of small tools, Pratt & Whitney Co., Hartford, Conn., has been nominated for president of the American Society for Steel Treating for 1932. For the past year he has been vice president. W. B. Coleman, president, W. B. Coleman Co., Philadelphia, a director of the society for the past two years, was nominated for vice president.

* * *

Lawrence Carr Steele recently joined the staff of the Aetna-Standard Engineering Co., Youngstown, O., as consulting engineer on sheet and tin plate equipment. He formerly was a consulting and experimental engineer with several sheet and tin plate plants. Mr. Steele holds more than 200 patents.

* * *

K. G. Mackenzie has been appointed by the American Society of Testing Materials to represent it on the division of engineering and industrial research of the National Research council, in place of T. D. Lynch whose term of office has expired.

* * *

Randolph F. Hall, formerly of the Thomas-Morse Aircraft Corp., and until recently chief engineer of the Cunningham-Hall Aircraft Corp., Rochester, N. Y., has resigned.

* * *

James E. Glidewell, formerly engineer of the Hall-Scott Motor Car Co., Berkeley, Calif., has been promoted to assistant chief engineer.

* * *

James A. Powell, vice president and assistant chief engineer of W. S. Barstow & Co., recently was honored with the degree of doctor of science by North Carolina State college. The degree was awarded in recognition of his outstanding accomplishments in the field of mathematical engineering.

* * *

O. L. Egtvedt, vice president of Boeing Airplane Co., Seattle, Wash., has assumed direct management of the company. He entered the services of the organization in 1917 as design engineer.

* * *

Robert N. Janeway, consulting engineer, has joined the engineering staff of the Chrysler Motor Corp., and will be associated with R. K. Lee, director of research.

* * *

George C. McCormick, chief engineer of General Alloys Co., Boston, has been elected a vice president of the company.

* * *

A. C. Willard, professor of heating and ventilating and head of the mechanical engineering department at the University of Illinois, has been named chairman of a special heating, ventilating and air-conditioning committee to cooperate with the White House conference in Washington, D. C.

* * *

Otto Nonnenbruch, for the past four years chief engineer of the diesel department of I. P. Morris and De La Vergne Inc., Philadelphia, and prior to that with Worthington Pump & Machinery Corp., Harrison, N. J., in various capacities for nine years, recently rejoined the latter organization.

* * *

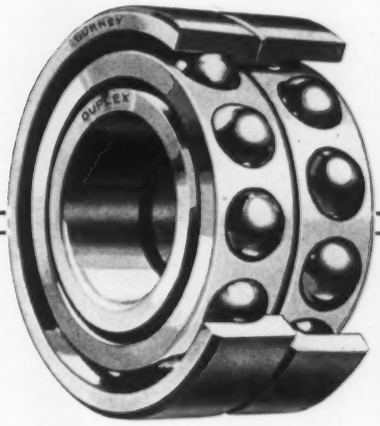
Walter C. Robbins, formerly vice president in charge of engineering and manufacturing of the Gabriel Co., Cleveland, has been made vice president and general manager of the Thermo Hydraulic Shock Absorber Co., Cambridge, Mass.

* * *

Dr. H. W. Gillett, director of Battelle Memorial Institute, Columbus, O., has been appointed a member of committee E-9 on correlation of research for five years by the American Society for Testing Materials. He succeeds Dr. G. K. Burgess whose term expired with the recent annual meeting. Dr. Burgess has been a member of the committee since its organization in 1924 and has rendered inestimable service.

* * *

Othmar Farl Marti, formerly chief engineer of the American Brown Boveri Co., Camden, N. J., now is associated with Allis-Chalmers Mfg. Co., Milwaukee, in the capacity of engineer in charge of rectifiers and railway equipment. The American Brown Boveri company was purchased some time ago by Allis-Chalmers company and many of the staff of that organization are now with Allis-Chalmers.



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gives Longer Bearing Life at 10,000 to 50,000 r. p. m.

THE extreme precision and ultra-quality of the Gurney "high-speed" Duplex Ball Bearing gives it surprisingly long-life at spindle speeds from 10,000 to 50,000 r. p. m. The accurately matched, two-unit construction of this bearing gives equal load distribution under very heavy spring pressures . . . automatically holding bearing and spindle in accurate adjustment . . . and assures a smooth, accurate finish at all times.

Two salient features of the Gurney "high-speed" Duplex contribute greatly to its wear-free, low heat operation. First—new high standards of concentricity . . . inner race eccentricity of .0001" or less . . . are secured through precision workmanship and recently developed improvements in methods of grinding. Second—the use of accurately balanced, one-piece ball retainers of a fine linen base material bonded with Bakelite, considerably reduces bearing wear at extreme speeds. Full particulars regarding the Gurney "high-speed" Duplex Ball Bearing will be gladly furnished.

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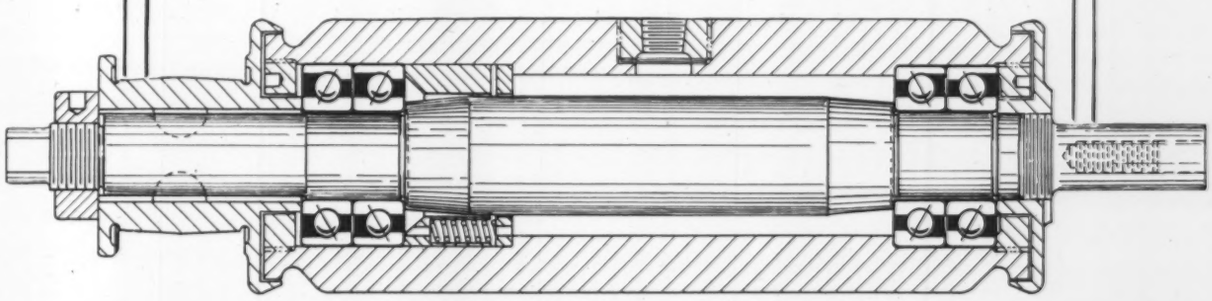


GURNEY BALL BEARINGS

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

RESULTING from a statement made recently by Roy V. Wright, president of the American Society of Mechanical engineers. that $500,000 was needed to discover a remedy for the present industrial situation, Henry L. Doherty, president of the Cities Service Co., has made an offer of that sum for the purpose.

According to Mr. Wright, engineers and scientists caused the depression by throwing production out of balance with consumption and distribution and stated that money was needed to provide for a study of the situation.

In making the $500,000 offer, Mr. Doherty disagreed that applied science is responsible for the present unemployment. The need, he said, is for "a remedy that can be promptly applied," therefore the sum is to be used for an unemployment remedy and not for lengthy research. All proposals he had seen so far, he added, had been rejected "as being worthless, if not fantastic."

* * *

Only 10 Per Cent of Engineers Are Inventors

IT IS surprising to note that but 10 per cent of the engineers listed in *Who's Who in Engineering* have made inventions. The reason for this, Dr. Joseph Rossman asserts in the *Journal of the Patent Office Society,* is that the engineer's training tends, to some extent, to kill initiative. "There are few engineering schools in the country," says he, "that encourage original or creative work on the part of their students. No courses are given to stimulate or bring out originality . . . . Most of the time is spent in studying textbooks and authorities, so that by the time the student graduates any originality which he might have had has been completely stifled and suppressed."

The engineering profession admits that for some strange reason inventions and inventors are not properly valued by its members. The statement of one engineer regarding this condition is interesting. He declared that the instant the engineer begins to invent things he loses cast with his profession because his work is new and cannot, therefore, be based upon past experience. Consequently it is not considered good engineering practice. It creates doubt, protest and ridicule to all of which the inventor must be deaf.

The publication *Power,* in an editorial, states that it is perhaps to be expected that only the exceptional engineer should be of value as an inventor. "Engineers must be careful, precise, painstaking—qualities which do not easily go with imagination and daring, essential to invention. We cannot spoil our engineers to make inventors. At the same time it is to be hoped that more and more engineers will train themselves to make fundamental contributions in the form of inventions."

* * *

Museum Gets Original Diesel Aircraft Engine

SMITHSONIAN INSTITUTION has been presented with the original Packard aircraft diesel engine with which the pioneer flights of an airplane equipped with this type of motor were made. Donated by the Packard Motor Car Co., the national aircraft collection administered by the Smithsonian Institution will be its place of repose in the National Museum. With it are pioneer engines of Stringfellow, Clement, Langley and Manly, the Wrights, Curtiss, the first Liberty and others.

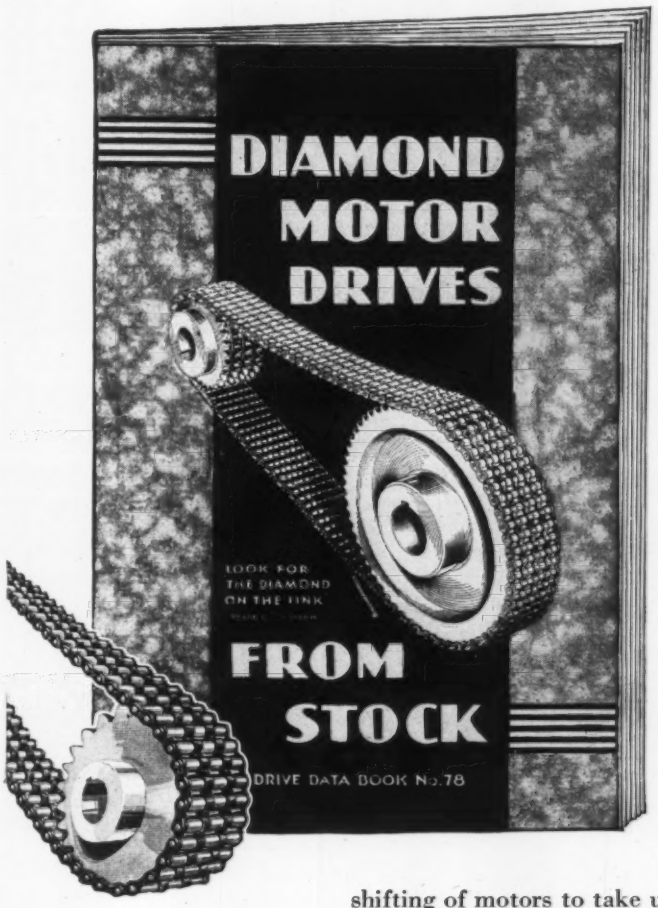
The late L. M. Woolson directed the designing and building of the Packard diesel, described in detail in the April, 1930, issue of MACHINE DESIGN. Furnace cil instead of gasoline is used as fuel. The production engine, slightly refined from the original, received the first approved type certificate award by the department of commerce for any diesel aircraft engine on March 6, 1930.

* * *

New Zealand Is Using More American Machinery

AMERICAN industrial machinery has made rapid advances in New Zealand during the last few years, according to a report to the commerce department from Trade Commissioner Julian B. Foster. Total imports of machinery into New Zealand in 1930 had a value in excess of $4,500,000 of which amount about $1,212,000 represented items from the United States. Imports of dredging and excavating machinery reg-

THE "PERFECTED" MOTOR DRIVES



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Diamond Drives are used in 112 major branches of American Industry—they are the same type of drives as the timing drives standard on such high grade motor cars as Marmon, Nash, Fiat and Lancia (Italian) where the drives must combine all the features you get when you use Diamond "Perfected" Motor Drives.

Diamond Drives are carried in stock for immediate delivery by the firms listed below. Note the one nearest you and ask them for quick delivery the next time you need a drive. DIAMOND CHAIN & MFG. Co., 435 Kentucky Ave., Indianapolis, Ind.

Ask for this Drive Catalog No. 78

Your nearest distributor or we will supply a copy. With it the selection of the right drives is just a matter of turning to the right page.

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DIAMOND STOCK DRIVES

A-4240

istered the largest gain, rising from $125,000 in 1929 to $195,000 in 1930.

The United States' share in this business amounted to 64 per cent and 59 per cent, respectively. Boring and well-drilling apparatus likewise showed a substantial increase, and again the proportion of American equipment involved amounted to more than half the total. In his report, Trade Commissioner Foster emphasized the fact that the labor-saving applicability of American machinery has been clearly recognized in New Zealand.

* * *

Suggests Plan to Relieve Unemployment

TO ASSIST in relieving unemployment and the economic depression, Harvey N. Davis, president of Stevens Institute of Technology, suggested that the colleges of the country embark on a $300,000,000 building and upkeep program. In an address before the economic conference held recently under the joint auspices of the alumni of Stevens institute and Columbia university at the former's engineering camp, he called on philanthropists to contribute to this sum for the much needed improvement of American universities. Mr. Davis proposed that $200,000,000 be spent for new buildings and $100,000,000 for the maintenance and repair of old ones.

* * *

To Manufacture Diesel Engine Truck

WORD comes that the Indiana Truck Corp., Marion, Ind., is commencing the manufacture of trucks equipped with diesel engines. It was the experiments of C. L. Cummins, head of Cummins Engine Co., Marion, Ind., that paved the way for this project. In this connection it will be remembered that a car powered with a diesel engine was entered by Mr. Cummins in the international speedway classic at Indianapolis last Memorial Day and was one of the first cars to go through the entire race without a stop. Economy in fuel consumption is a feature of the new truck.

* * *

Early Automobiles Had Engines in Rear

AS WITH many other so-called innovations the advent of the rear-engined automobile is not so new as it seems. In the beginning of the industry, says the historical department of the Society of Automotive Engineers, the engine frequently was installed in the rear of the car or under the back seat. In the early roadsters it was made readily accessible by the mere lifting of the rear deck or the opening of the body tail gate. Single cylinder engines were mounted this way so that the spark plug and carburetor could be easily reached. Then came the double-opposed engine, the rear cylinder occupying the usual position while the opposing cylinder stretched forward horizontally under the body.

* * *

Development of New Engine Aids Business

EXEMPLARY of the trend toward inaugurating new developments to keep industry moving, a slow speed heavy duty internal combustion motor using natural gas as fuel has been designed by Minneapolis-Moline Power Implement Co. The new engine is said to be the first of its kind manufactured for commercial use. It is adaptable to slow moving stationary machinery, and where natural gas is available unusual economies in operation are effected by its use.

The new unit has a range of about 800 to 1000 revolutions per minute, instead of 1500 to 3000 usually developed by the ordinary internal combustion engine. It is a modification of a type of slow speed motor built for the use of kerosene or gasoline fuel.

* * *

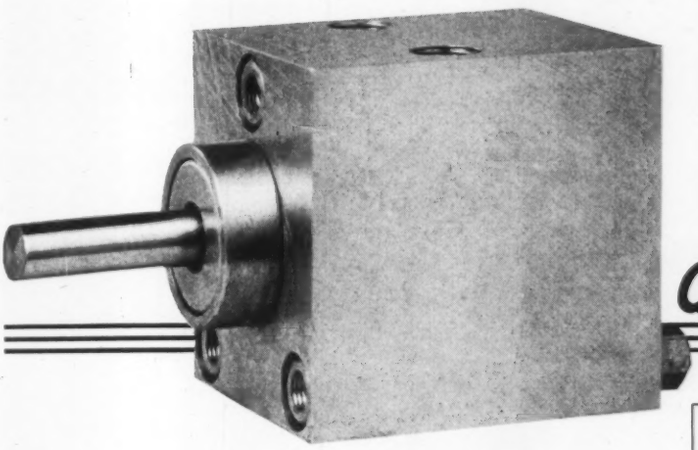
Exposition of Metals Is Held in Boston

NEWLY developed steels and alloys, new and improved processes and equipment were features of the displays at the Thirteenth National Metal exposition held in Commonwealth Pier, Boston, Sept. 21-25. These developments were perhaps more numerous than in metal shows of recent years, but this was not unexpected since periods of depression stimulate research. Corrosion-resisting steels assumed a prominent position in the show, with nearly 20 manufacturers displaying the material in sheet, strip, bar and wire form as well as in hundreds of fabricated products.

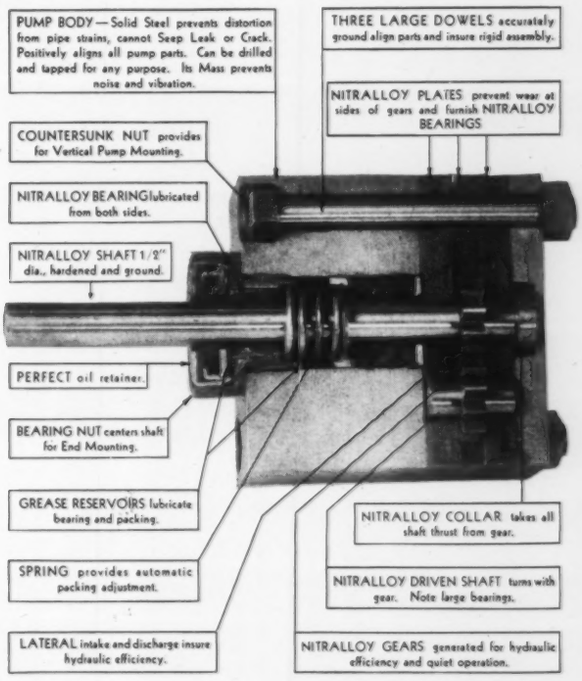
Two manufacturers exhibited combination steels consisting of 80 to 90 per cent open-hearth steel to which is veneered by a special welding process 10 to 20 per cent of rust-resisting steel. Veneer steel of varying compositions can be applied and the backing steel can be furnished in carbon contents up to 1.10 per cent. This combination steel is suitable for welding.

In a paper before the meeting of the American Society for Steel Treating held in conjunction with the show, R. L. Sanford of the bureau of standards, discussed the characteristic magnetic phenomena which may be observed when steel is heated or cooled, and showed how they may be interpreted in terms of the corresponding structural transformations. Thermomagnetic analysis, on account of its great sensitivity, offers a means for studying some changes in the structure of steel which can be observed in no other way.

Install ▸▸▸ NITRALLOY STEEL PUMPS



and forget them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THREE LARGE DOWELS accurately ground align parts and insure rigid assembly.
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NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

INCREASE in application of hydraulics in design of machinery has advanced the need for pumps, among which is a newly patented unit designed by P. O. Ott for the Racine Tool & Machine Co., Racine, Wis. The rotor is equipped with inlet and discharge valves and vanes or blades working in a casing. This casing includes a cylindrical member which is free to revolve with the rotor during the working cycle of the pump and is designed to be shifted relative to the rotor for controlling the delivery of pressure fluid.

Details of the section of the pump, the drive for which may be through an electric motor or other type of prime mover, are shown in *B*, Fig. 1, shaft 45 having geared connection with shaft 12. During the time the vanes are passing through the lower half of their revolution, the space 26 between the body of the rotor and the ring 20 gradually is enlarged and suction takes place. The balls 27 rise off their seats during this time to admit the fluid from passage 22 and ports 21. As the vanes pass through the upper half of their revolution the space between them and the rotor and ring gradually contracts and the fluid is discharged past the ball valves into the discharge line 25.

Since the travel of the blades in and out relative to the rotor is dependent upon the eccentricity of ring 20, it will be evident that decrease in this eccentricity will reduce the volume of liquid handled between the blades. Finally, at zero eccentricity or when the center of revolution of ring 20 coincides with the axis of rotation of the shaft no displacement by the rotor and no reciprocating movement of the blades takes place; consequently no liquid will be pumped. Furthermore, the device is so designed that the rotor with its vanes and the ring 20 provides a series of radially disposed pumping chambers in which the pumping cycle successively takes place as the rotor revolves to discharge the fluid into the passages 25 and 53, shown in Fig. 1 *B*.

Various means may be used for adjusting and maintaining the support 63 in the desired angular adjustment and as one example there is shown in *A*, Fig. 1, the support 63 provided with a stud 82 projecting vertically through an opening, against a manually adjusted screw 84 in threaded engagement with a lug in the casing section 9. The reaction of the moving parts tends to hold the stud 82 against the screw which may be turned in or out of its mounting in the casing to swing the support toward the left, or vice versa, thus varying the eccentricity of the pump cylinder 20. The number of the patent for this hydraulic pump is 1,819,689.

OVERRUNNING clutches afford many possibilities in the design of machinery and in view of their prevailing popularity the newly patented device developed by Raymond F. Mullen will be of interest to designers. This inven-

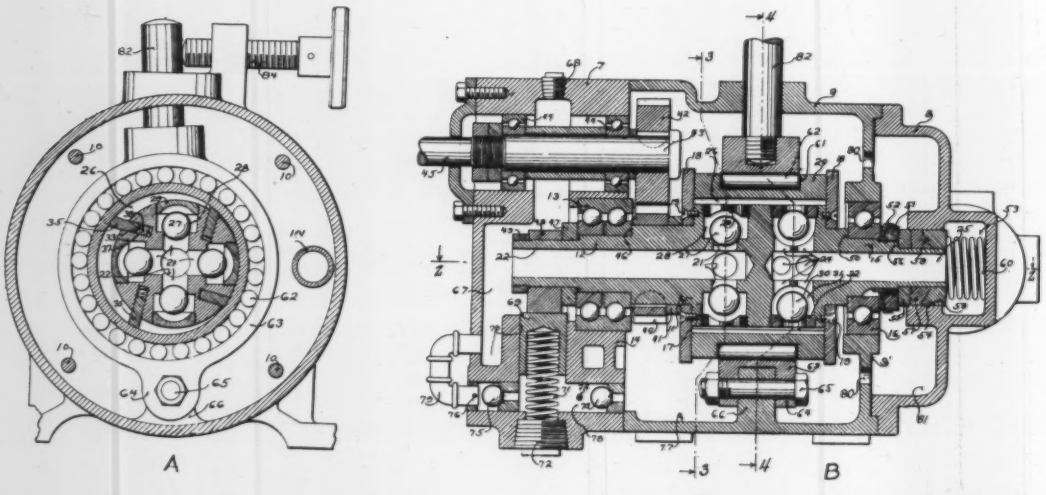

Fig. 1 — A shows details of delivery control valve of hydraulic pump. A cross section of the pump, depicting the design of parts by which pressure is built up and controlled, is shown at B

R-E-A-D

Hamilton-Sangamo turned production of their vitreous enameled clock case over to G. P. & F. Result: a very beautiful case at a very interesting price.

HOW TO MEET THE UNESCAPABLE CRY FOR LOWER PRICES

The voices of sales units and retailers everywhere are raised in a huge national chorus: "Give us lower-priced merchandise—bargains which even the hard-boiled prospect of today cannot resist."

In self-defense, no manufacturer can disregard that cry. G. P. & F. stampings have aided many manufacturers and may bring savings to you also. Perhaps *you* can get an idea from reading the following examples:

Cost Savings

A lower crankcase for automobile motor was stamped from 16 gauge steel by G. P. & F. at a cost of about one-half that of the former aluminum casting.

●

A carburetor manufacturer saved $5,000 on raw material alone on the first production schedule of 50,000 units—when he changed from cast brass shells to G. P. & F. drawn brass shells. The change saved 1½ lbs. of brass per unit. Later he changed to sheet steel, making still further savings.

●

A unit formerly cast was redesigned for G. P. & F. pressed-metal production. On 5,000 units, $500 was saved in machining costs and more than $1,000 in metal costs. The better finish and appearance of the pressed unit enabled the manufacturer to outsell competition at a profit.

●

A body for an automobile jack was formerly cast of aluminum. Now it is pressed by G. P. & F. from steel at a 50% saving plus a marked reduction in weight and an increase in strength. The aluminum casting weighed 14 ounces; the pressed steel body weighs only 10 ounces.

●

A 25% saving in material, an elimination of machining and assembling operations were achieved by using G. P. & F. stampings instead of castings in a built-up traffic-signal post.

Weight Savings

A pump manufacturer replaced a cast unit with a G. P. & F. drawn unit and saved 73 lbs. of metal per unit.

●

A business machine with its G. P. & F. pressed case weighs 12 lbs. less than it weighed with a cast enclosure.

●

On another business machine, a two-thirds reduction in weight was made by the change to G. P. & F. drawn covers.

●

An oil pan for a machine tool weighed 28 lbs. when cast, was heavy and brittle, and required grinding and buffing. The same pan made of G. P. & F. pressed steel weighs only 5 lbs., 14 ozs., stands vibration better, is stronger and requires no finishing.

●

If these hints suggest anything to you, send a sample or blueprint for quotations. First of all send for the valuable book "*In Harmony with Modern Progress*".

●

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G.P.&F. STAMPINGS

tion pertains to the one-way type of clutch in which a cylindrical outer shell and an inner member are arranged concentrically with friction rollers interposed between them. The inner member has cam surfaces so that in one direction of rotation the rollers are pinched be-

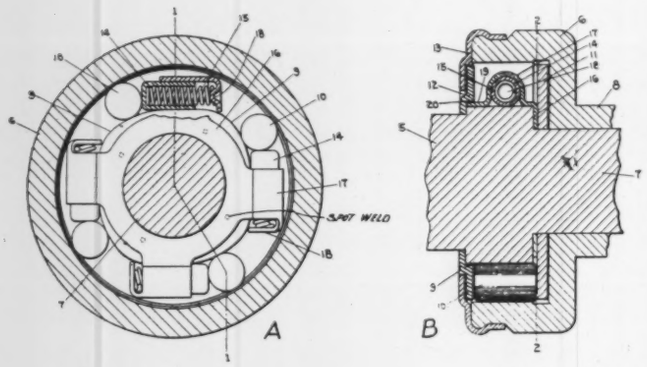


Fig. 2—Arrangement of compression spring plungers against friction rollers in clutch

tween the opposed surfaces, thus locking the clutch parts together for simultaneous rotation.

One of the objects of the invention is to produce a clutch in which the cam member is formed inexpensively from stock of small diameter by simple operations, this arrangement being particularly important from the standpoint that the cam surfaces may be produced by a continuous peripheral grinding operation which does not require the use of a formed grinding wheel.

As seen in Fig. 2, *A* and *B*, a spring follower behind each roller acts to press the roller in the direction in which it will pinch between the surfaces. Each spring follower is made in the form of a hollow plunger 14, and encloses a coiled compression spring 15. Designed to be formed of sheet metal, the guide member 16 is a comparatively easy piece to fabricate. This guide member is fixed against rotation with respect to the cam, being fitted tightly upon it, and may be secured in position by spot welding the ring portion to the adjacent surface of the cam. The number of this patent is 1,820,151 and the North East Appliance Corp., Rochester, N. Y., is the assignee.

TO ELIMINATE excessive pressure of the yoke against the ring, Alfred W. Place has designed and patented a universal joint, shown in Fig. 3, which provides a clearance at the points of greatest pressure. He also has provided a relief valve which will open and permit the escape of oil whenever a predetermined pressure is reached in forcing oil into the joint.

When lubricant is being supplied to the joint and the oil level rises above the center of the housing, air is trapped in the upper part. As more oil is forced into it this air is compressed, and when the pressure reaches a predetermined point the valve 24 (A, Fig. 3) opens. The oil then is released through bore 21. This prevents pressure in the housing from becoming too great and forcing the wall of the unit outwardly, disrupting the oil seal and causing a leaky joint.

As the joint operates at an angle as shown in Fig. 3, and the ring 13 is turning in the direction indicted by the arrow *a*, there will be torsional resistance exerted by the yoke 7 in the direction indicated by the arrow *b*. Because of the slight movement of the yoke pin 16 in the bearing hole in the ring there is a tendency for the ears 18 of the yoke to exert considerable pressure at diagonally opposite points against the inner surfaces of the bearing portions 15

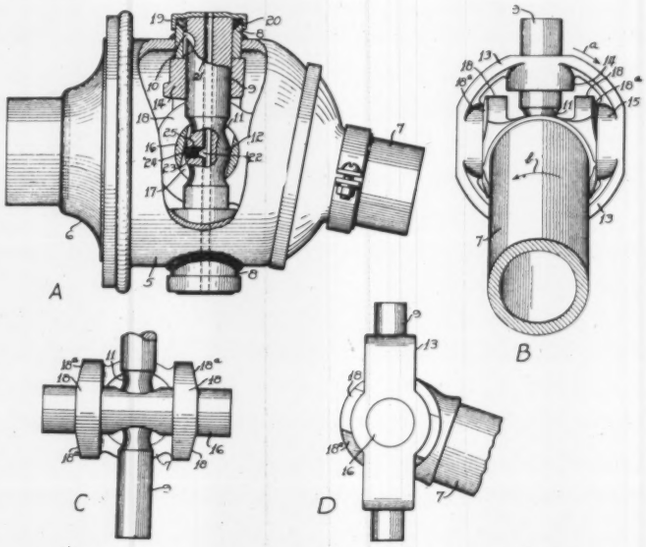


Fig. 3—Universal joint designed to eliminate friction and excessive oil pressure

of the ring. To obviate such a condition the outer faces of the ears 18 have been slightly beveled as indicated at 18ª, Fig. 3*C*.

This new invention is listed as patent No. 1,790,677, which has been assigned to Superior Universal Products Co., Bowling Green, O.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

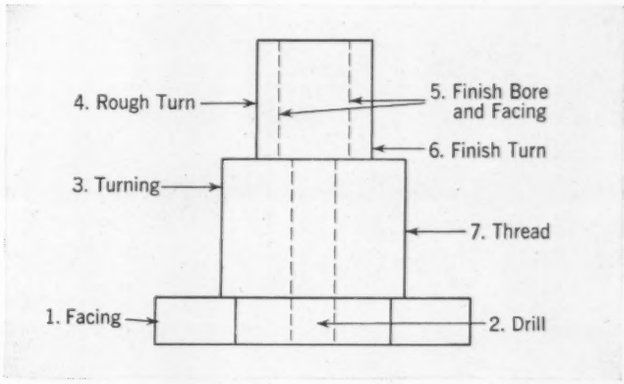
BALL BEARING MOUNTING—1,810,093. A ball bearing mounting for the shafts of weighing apparatus, comprising a cup-shaped annular body member, the open end whereof is outwardly disposed. Bearing balls are adapted to be disposed concentrically about the shaft, the balls being of a diameter such that the peripheries thereof contact simultaneously with the bush member. Assigned to W. & T. Avery Ltd., Birmingham, England.

CHANGE SPEED GEARING—1,811,921—In describing this patent on pages 66 and 68 of the September issue of MACHINE DESIGN the inventor of the device was inadvertently given as Howard M. Edwards. It should have been Howard M. Edmunds who is manager, speed changer department, Crocker-Wheeler Electric Mfg. Co., Ampere, N. J., to which company the patent has been assigned.

Revere Brass Forgings

prove SUPERIOR

. . . not by opinion or guesswork . . . but by comparative tests



A certain manufacturer wanted the real facts on Revere Brass Forgings. So the engineering department set up a series of comparative tests. A swab drain plug was made the subject of test and put into work under regular production conditions . . . using castings of three different mixtures and Revere Brass Forgings. The following is the concise, uncompromising report of how Revere Brass Forgings proved superior to castings:

NO. 1 MIXTURE:

Long turnings. Thread appeared to be burned. Heat noted during cutting. Two (out of eight) pieces leaked when tested to 90 pounds-per-square-inch air pressure, under water. Finished weight 15.6 oz. Weight lost in machining, 6.6 oz. No regrinding of tools. Feed 210 r.p.m. per inch. Average time 5 min. 2 sec.

NO. 2 MIXTURE:

Small turnings, no long ones. Threading tool did not smoke while cutting; threads did not discolor as in No. 1 Mixture and were smoother. No leaks on air test. Finished weight 15.3 oz. Weight lost in machining 7.2 oz. No. 1 Facing Tool was dulled in trying a greater feed than 210 r.p.m. per inch on piece No. 2 and had to be reground. Average time 5 min. 5 sec.

NO. 3 MIXTURE:

Small turnings as in case of No. 2 Mixture. Clean thread. More heat developed while cutting than No. 2 Mixture. No leaks on air test. Finished weight 15.7 oz. Weight lost in machining 6.8 oz. Feed 210 r.p.m. per minute. Average time 5 min. 6 sec.

REVERE BRASS FORGING:

Metal cut easily, excellent threads. No evidence of heating. Ran coolest of samples while cutting. None leaked on air test. Finished weight 14.7 oz. Weight lost in machining 5.3 oz. No regrinding of tools. Can be cut at 117 r.p.m. per inch, while others cannot be cut at a greater feed than 210 r.p.m. per inch. Average time 4 min. 42 sec.

CONCLUSIONS: Revere Brass Forgings cut more easily, and at a greater feed. Consequently less time is required in machining. They are lighter in weight, and there is a considerable saving in waste.

Revere Brass Forgings have, time and again, proved superior for a wide variety of purposes. Besides being more economical (45% reduction in machining costs is not unusual) they make better parts.

For further information address Revere Copper and Brass Incorporated, 230 Park Ave., N. Y. C.

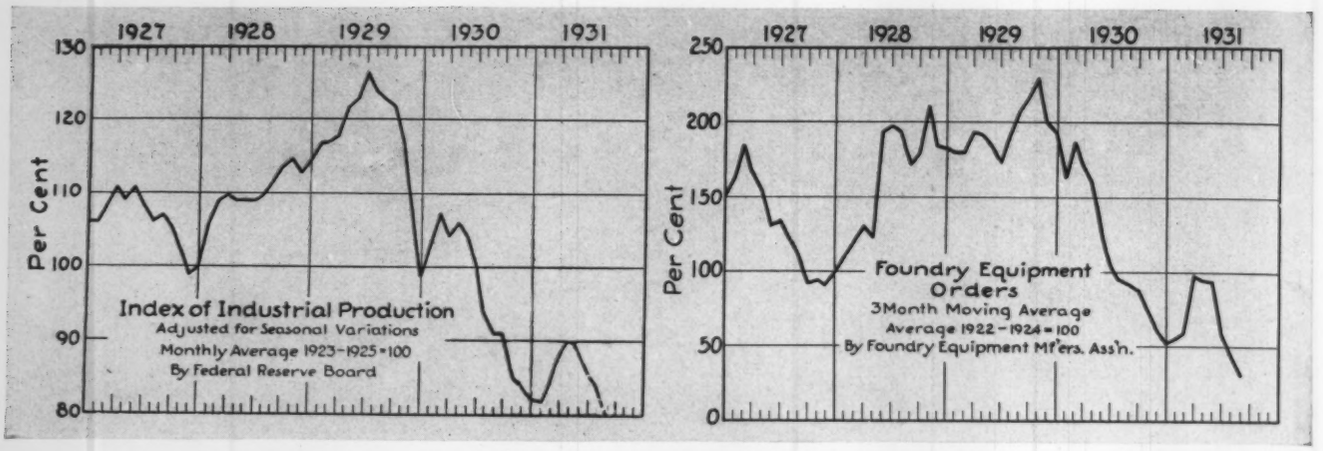
Revere Copper *and* Brass

INCORPORATED

Revere COPPER BRASS Products

Baltimore *Division, Baltimore, Md.* Michigan *Division, Detroit, Mich.* Higgins *Division, Detroit, Mich.*
Dallas *Division, Chicago, Ill.* Taunton-New Bedford *Division, Taunton, Mass.* Rome *Division, Rome, N. Y.*

EXECUTIVE OFFICES: NEW YORK CITY
GENERAL OFFICES: ROME, N. Y.

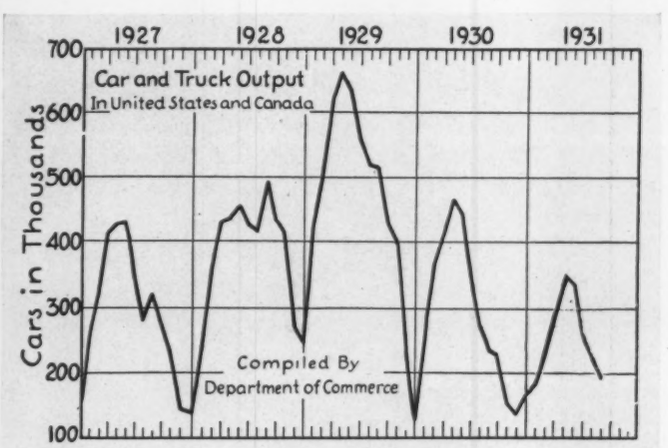


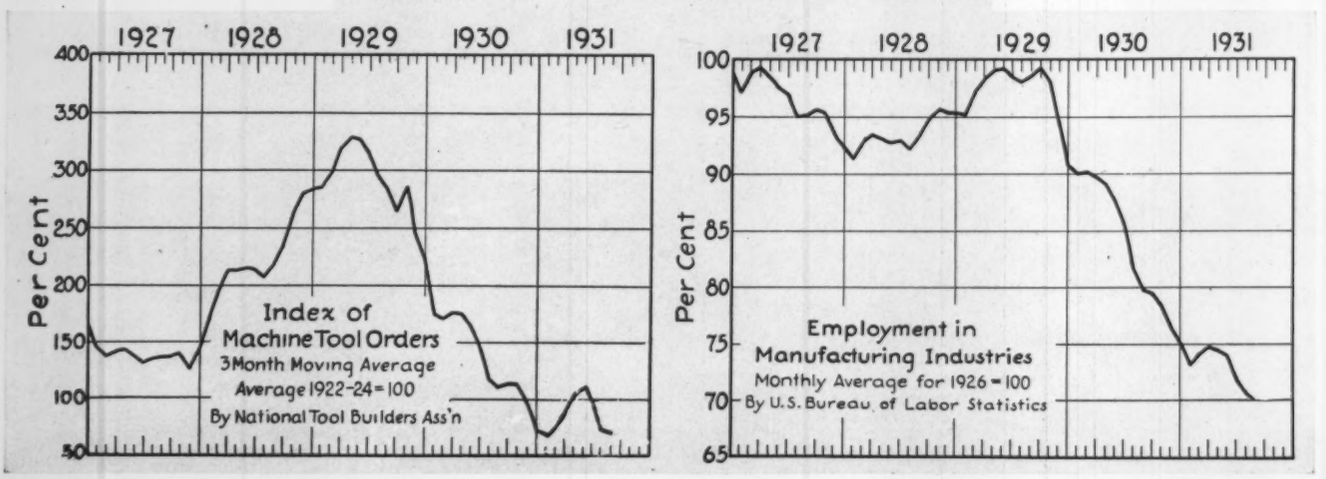
How Is Business?

WITH business discarding most of its illusions and adjusting costs to the most drastic extremes possible, it is apparent that industrial leaders are "clearing decks" and preparing to take advantage of every point in the battle to restore failing trade. This is in itself a healthful indication. Childish trust that "things will improve soon" will do more harm than good to actual improvement.

The expected advance has demonstrated miragical qualities, receding almost as quickly as the expected turning point has been reached. The apparently mythical point is at least getting closer, for the illusion of improvement in September was not destroyed completely until the latter part of August. And even at that time some industries reported increases and order-book backing for the expectation of greater improvement during the fall months. However, Col. Leonard Ayres' index of American industrial activity touched in July a point as low as any it has reached since 1790.

Active merchandising, improved models and a price cut has stimulated the electric refrigerator industry which reports 1931 sales well above those of 1930, the previous high year. Timely adjustment of merchandise and sales policies in line with the shifting trends also has benefited the manufacturers of vacuum cleaners. Here again new and improved models provided the stimulus for the sales force, although in this case reduced prices had little to do with the final result.





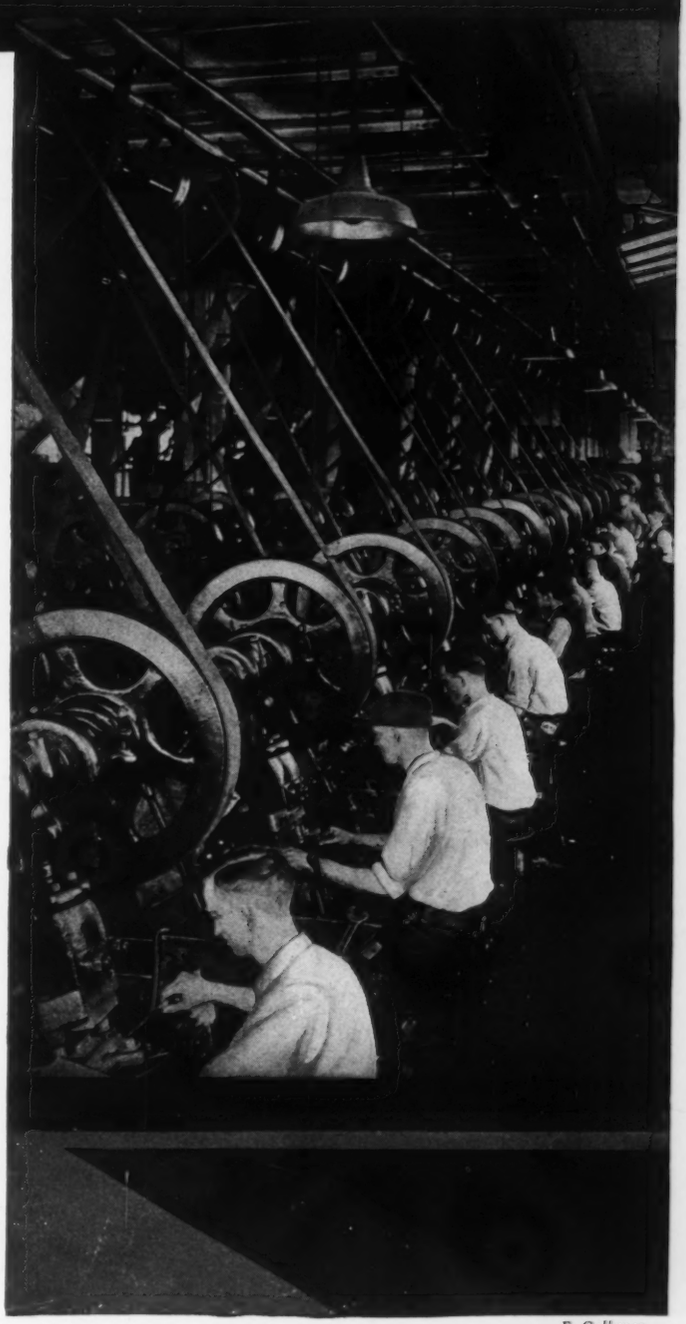
Alloy Steel gives Longer Life to Equipment

The longer equipment lasts the greater the returns on your initial investment. The longer you keep a machine running efficiently, the higher dividends it pays. Short-lived equipment is a drag on your profits. Units that are continually out of service for repair pile up needless expense.

Multiplied work power and longer life may be obtained through proper utilization of the superior physical properties of Alloy Steels and Irons. Small amounts of chromium, manganese or vanadium in these metals provide the increased tensile strength and greater resistance to abrasion, impact, distortion and fatigue necessary to longevity.

Alloy Steels and Irons assure minimum interruption of production for repairs. They should be carefully considered for any part that wears out or breaks before the equipment itself is obsolete.

Electromet engineers will gladly explain how longer life is achieved by the use of Ferro-Alloys in Alloy Steel and Iron.



E. Galloway

ELECTRO METALLURGICAL SALES CORP.
Unit of Union Carbide UCC *and Carbon Corporation*
Carbide and Carbon Building, 30 East 42nd Street
New York, N. Y.

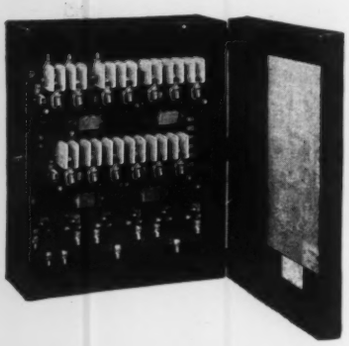
Electromet
Ferro-Alloys & Metals

NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Switches Afford Overload Protection

COMPLETE protection against overloads through the use of thermal overload relays for each speed is provided by the bulletin 715, automatic multispeed across-the-line switches developed by Allen-Bradley Co., Milwaukee. These switches, shown herewith, are for two, three or four speed, nonreversing service in connection with two or three phase, multispeed motors of consequent-pole winding or separate winding type, in ratings up to 40 horsepower, 220 volts, and 75 horsepower, 440-550 volts, 25 to 60 cycles. No-voltage protection is



Thermal overload relays give complete protection against overload on multispeed switches

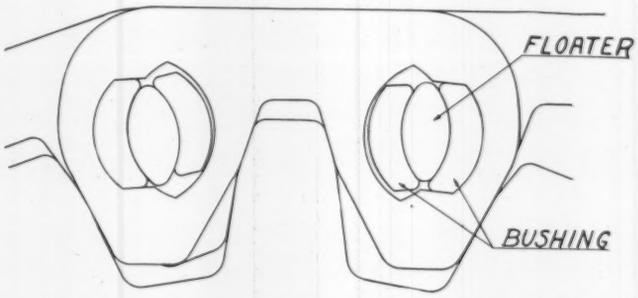
a standard feature with 3-wire control, and no-voltage release with 2-wire control.

These switches consist of two or more magnetic switches operated from control stations having 3, 4 or 5 push buttons. An optional feature is a slow speed start interlock, which compels the operator to follow a definite sequence in starting the motor, always starting with the first speed and then advancing through the second, third and fourth.

Chain Gives Uniform Power Flow

IN ORDER to provide a uniform flow of power from the driving motors to all rotating parts, as required in modern precision machine tools, the Morse Chain Co., Ithaca, N. Y., has developed a new product known as Pumpkin Seed chain or type No. 2167. The outstanding points of the chain, shown herewith, are its contact on the sprocket teeth, and its joint action. The chain joint consists of the center pin, or "floater" and two bushings. The action of the floater is twofold, to give a uniform, nonpulsating pull in the chain and to carry the forward end of each link onto the sprockets with a minimum rising and falling motion.

In the design of the chain it was determined



Special form of floater and bushings gives uniform pull to new-type chain

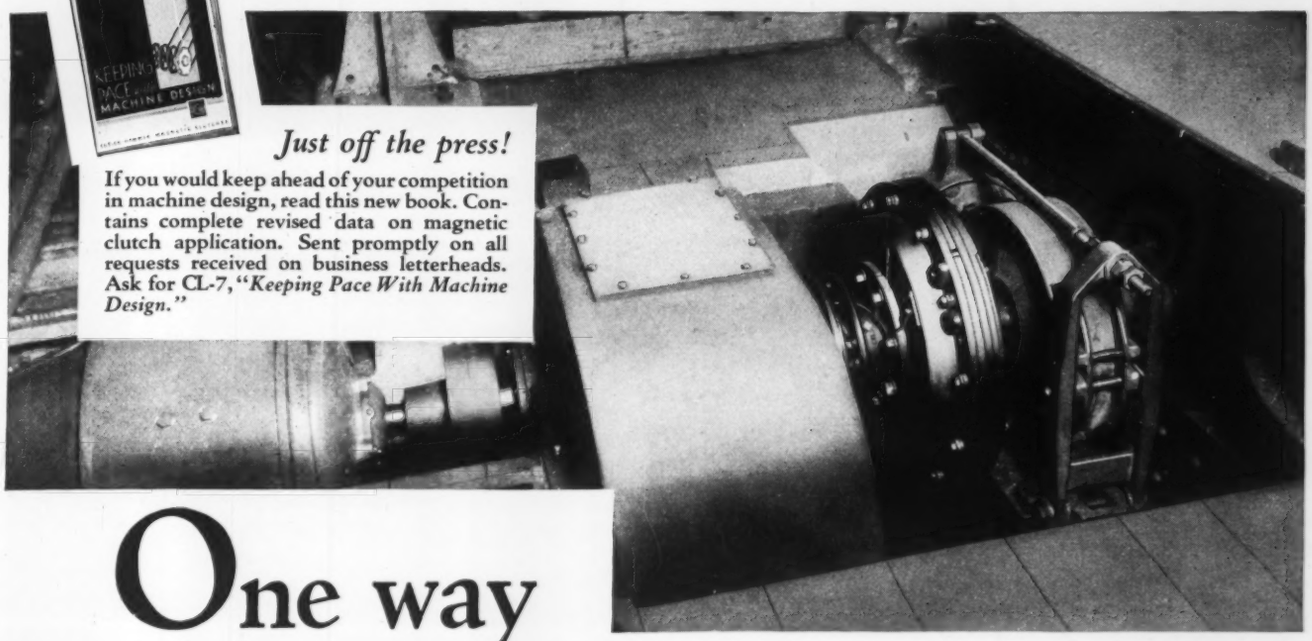
that the way to obtain uniform angular velocity by means of chain drive was to design a chain joint, which when flexing on a sprocket has its center of articulation follow the sprocket polygon rather than the pitch circle. The Pumpkin Seed chain accomplishes this by the lenticular center pin and the bushings by means of which it is possible to provide two centers of articulation. These centers are so located that the joint will articulate around one center, which moves along the sprocket polygon through the first half of flexing and around the other center, which also moves along the sprocket polygon, through the latter half of the flexing. The forward end of the approaching link is caused first to drop below the pitch circle and then rise to it, thus carrying the oncoming strand of chain without the rising and falling motion common to other chains.

Improves Heavily Coated Electrode

HIGHER ductility of weld metal is afforded by the improved, heavily coated electrode, for welding within the shielded arc on mild steel, introduced by Lincoln Electric Co., Cleveland.

Just off the press!

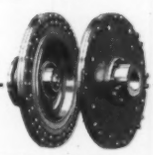
If you would keep ahead of your competition in machine design, read this new book. Contains complete revised data on magnetic clutch application. Sent promptly on all requests received on business letterheads. Ask for CL-7, "*Keeping Pace With Machine Design.*"



One way to write an effective "sales story"

C-H MAGNETIC CLUTCHES ON GEARS & FORGINGS, INC. WORM-GEAR DRIVE

Every machine-builder wants to provide trouble-free service; every customer wants to buy it. Gears & Forgings, Inc., Cleveland, Ohio, used a C-H Magnetic Clutch in the worm-gear drive shown above—and they advertise: "INSTALL THIS DRIVE . . . and forget about it". On this installation the G. & F. Drive, transmitting power to a pipe-bending machine, has been operating perfectly for years and the only attention it gets is periodic lubrication. Perhaps C-H Magnetic Clutches can help you provide a greater degree of trouble-free service in your product.



C-H Magnetic Clutches consist simply of two plates. They are engaged by magnetism, pressure being self-contained. Engagement of driven member with driving member running at full speed is smooth, jerkless, without grab or bounce, without shock to equipment.

SALESMEN are always hard-pressed for sales-points to make the prospect forget price-arguments.

Here is one way an increasing number of machinery-builders are "writing" a new and powerful sales story for their men . . . through the investigation, and adoption into their design, of C-H Magnetic Clutches.

Briefly, C-H Magnetic Clutches provide automatic operation, eliminate parts and reduce power-wastes. They are sturdy, rugged, simple . . . fitting in well with installations you want to "stay put" without trouble or attention.

A C-H Magnetic Clutch consists of two simple plates which are engaged by magnetism. They eliminate the need of toggle-joints, sliding collars, pivoted arms or heavy back-up parts. They eliminate end- or side-thrust. They are engaged by means of push-buttons, foot-pedals, or automatically with limit-, pressure-, float-switches and the like. They engage under any condition, smoothly, without jerk or jar . . . increasing machine and motor life appreciably.

Only investigation will show you whether you can apply them or not. The profitable possibilities . . . the fact that they today are serving on more than 3 million horse power . . . make that study worth while. Numerous suggestive applications are shown in the booklet CL-7. Send for a copy.

CUTLER-HAMMER, Inc.

Pioneer Manufacturers of Electric Control Apparatus

1326 St. Paul Avenue MILWAUKEE, WISCONSIN

CUTLER HAMMER

C-H

Magnetic Clutches Save Time and Save Equipment

(A-337)

Research and experiment have brought many improvements in this electrode, known commercially as Fleetweld. The new design insures 20 to 30 per cent elongation in 2 inches, while the tensile strength of coupons is increased about 10 per cent to average between 65,000 and 80,000 pounds per square inch. Resistance to corrosion, greater than mild steel, has been revealed by tests.

Reducers Are Unusually Compact

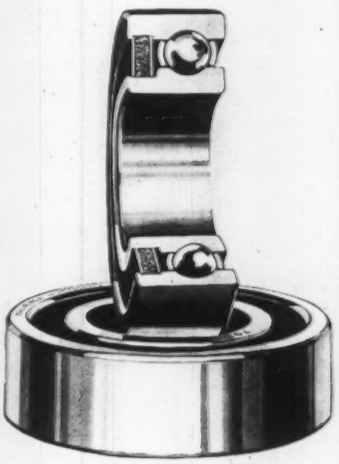
COMPLETELY enclosed in one case regardless of ratio, the Heliocentric speed reducer, a complete line of which is being manufactured by Universal Gear Sales Corp., Indianapolis, make a compact, small size unit particularly adaptable for incorporation as an integral part of a machine. The reducers, shown herewith, comprise a complete series of single, double and triple stage speed reduction units in capacities from ¼ to 150 horsepower and in ratios ranging from 20 to 1 to 1,000,000 or more to 1. They can be furnished in either straight-line, vertical or right angle drive.

As described in the March, 1930, issue of MACHINE DESIGN, the principle of operation of the reducers consists of an eccentric on the high-speed shaft, driving a series of plungers assembled radially in a spool piece mounted on the low-speed shaft. These plungers engage a stationary internal gear rack and move forward progressively on the rack, carrying the low-speed shaft around with them. The number of teeth in the rack determines the speed of reduction. More than a third of the total number of plungers are working at one time, giving a large area of contact between the plungers and the rack. The outer point of the plunger and the teeth in the rack are designed so that the plunger has a tendency to pull oil into the point of contact between the plunger and rack, thus reducing sliding friction.

All sizes of unique speed reducers are enclosed in the same casing

Bearing Is Protected by Felt Seal

SUBSTANTIAL thrust loads in either direction in combination with the radial load can be carried by the "7000" series of felt-protected closed-type ball bearings recently introduced by Norma-Hoffmann Bearings Corp., Stamford, Conn. The unit, shown herewith, is an all-steel, lubricant-packed, dirt and moisture proof bearing. It embodies the latest improvements designed to meet the growing trend toward simplification in mounting and lubrication, and a reduction in the cost of machining and assembling. Wide solid inner and outer rings give maximum contact on shaft and in housing; and the design is such that the bearing can be clamped on both sides.



Substantial felt washer and thin fiber ring protect closed-type ball bearing

The "Greaseal" feature consists of a substantial felt washer and a thin fiber ring interposed between split snap rings recessed to present a shoulder which, with the felt washer, forms an effective labyrinth as an added safeguard against escape of lubricant. There is ample space for grease, thus reducing the attention needed for proper lubrication. The "7000" precision ball bearing is made in a full range of sizes, interchangeable in overall dimensions with other makes of self-protected bearings.

New Device Provides Positive Contact

WHEREVER a positive, rapid and durable electrical contact is required, in circuits handling up to 1300 watts at 220 volts, the new vacuum contact developed by Burgess-Parr Co., Chicago, is especially applicable. The contact, shown herewith, can be operated by manual, me-

the leather is right—half a century's experience guarantees that . . . the spring is right—hundreds of tests have proved that . . . the

PERFECT OIL RETAINER

will seal lubricant leaks . . . indefinitely

OUR ENGINEERS WILL PROVE THAT BY MAKING FREE TEST INSTALLATIONS ON YOUR EQUIPMENT . . . WRITE OR WIRE

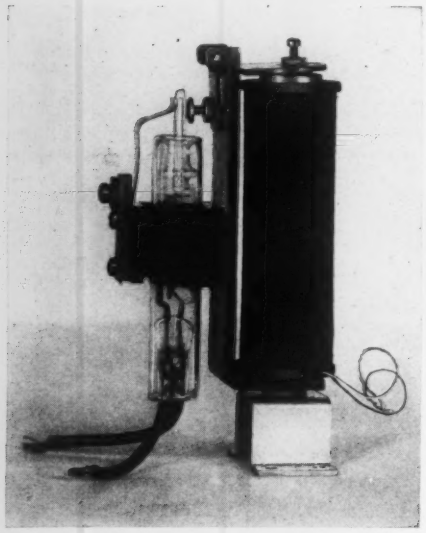
CHICAGO RAWHIDE MANUFACTURING CO. 1304 ELSTON AVE., CHICAGO

NEW YORK DETROIT CLEVELAND PHILADELPHIA PITTSBURGH

chanical, thermal or electromagnetic means.

Operation of the device depends upon the elasticity of a glass bellows in causing the mechanical actuation of contacts sealed in a vacuum. The glass bellows, because of its shape and special temper, is highly elastic. A slight movement of the stem is communicated to the movable block, causing it to separate from the contact block which is stationary. A spring causes positive connection between contacts when no pressure is being applied to the stem. The contacts are contained in the evacuated glass tube with connections made through leads.

This device is positively flameproof as it operates in vacuum and there is no exposed spark or arc to introduce a fire hazard. A movement of only 0.02-inch at the end of the stem, brought about by a force of less than 10 ounces, will operate the enclosed contacts. The usual force used is but 6 ounces, while the device can handle its rated current as fast as 40 breaks per second.

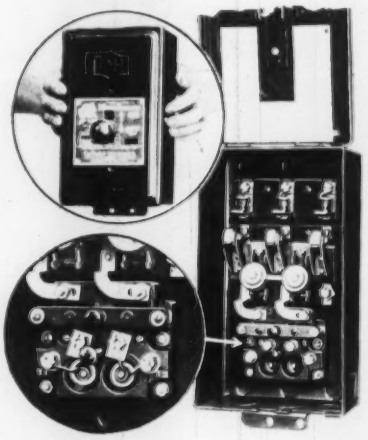


Elasticity of a glass bellows is basic factor in providing contact in new electrical device

Starters Incorporate Overload Relays

THREE and four-pole types, across-the-line "X" manual starters manufactured by Cutler-Hammer Inc., Milwaukee, have been redesigned to incorporate thermal overload relays in place of the thermal overload cutouts formerly supplied. The new bulletin 9115 starter, shown herewith, also has a redesigned cover interlock which prevents opening the enclosing case when the motor is running and allows padlocking the operating lever and the enclosing case in the "off" position.

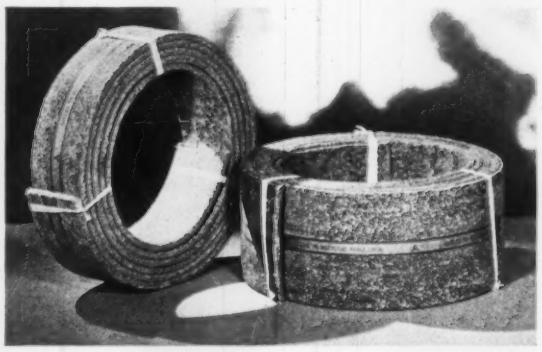
The overload relay provides many features which were not obtainable with the thermal cutout. Should an overload occur which may be dangerous to the motor, the overload relay trips, opening two lines to the motor so that the entire circuit is opened—the motor cannot continue to run on single phase. When tripped, there is nothing to renew—simply returning the operating handle to the full "off" position resets the overload relay and the motor can then be restarted. This eliminates time taken to renew the fusible clips of the old cutout. A trip indicator in the cover of the enclosing case shows whether the overload relay has been tripped.



Better overload protection is afforded by redesigned starting switches

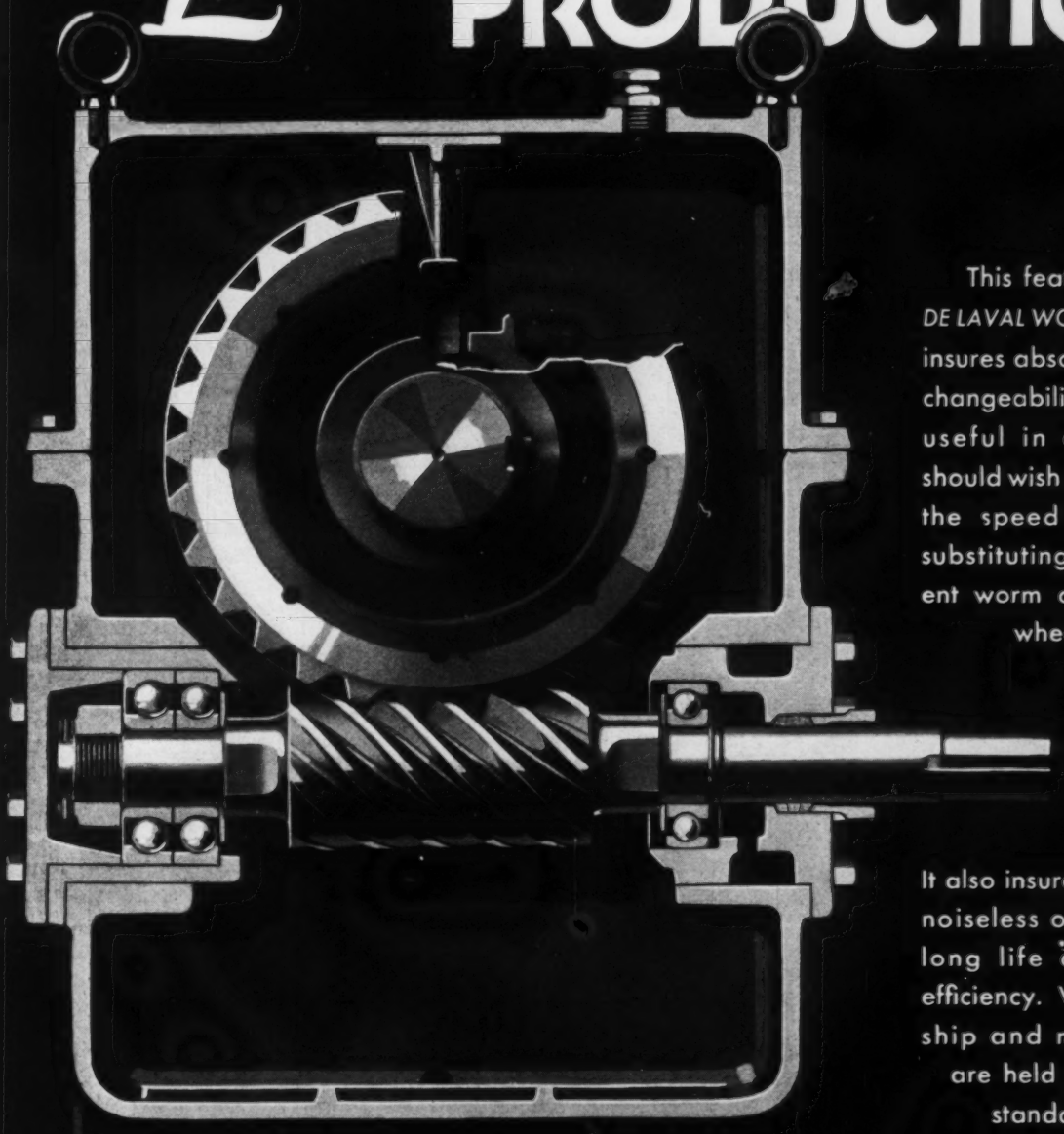
Introduce Industrial Brake Lining

BUILT for service and efficiency, the 701 industrial brake lining, developed by Garlock Packing Co., Palmyra, N. Y., is especially applicable for use in oil fields, sugar refineries, road building, steel and tubing mills, mines, and similar heavy duty service. The lining, shown herewith, is constructed of high quality asbestos cloth, impregnated with a special rubber com-



Heavy-duty brake lining will resist hard usage and wear found in industrial applications

Limit Gage PRODUCTION



This feature of *DE LAVAL WORM GEARS* insures absolute interchangeability of parts, useful in case you should wish to change the speed ratio by substituting a different worm and worm wheel.

It also insures correct, noiseless operation, long life and high efficiency. Workmanship and materials are held to strict standards.

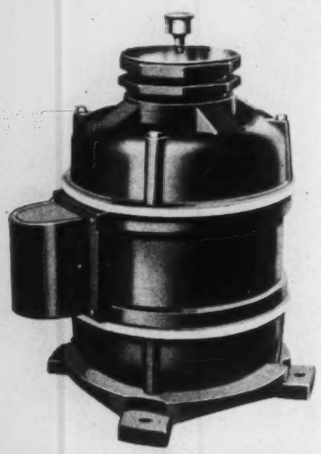
De Laval Steam Turbine Co.,
Trenton, New Jersey

DE LAVAL WORM GEARS

pound, then folded, molded and vulcanized under 2000 pounds pressure. This material, designed for long continuous service, is said to operate with fewer repairs.

Ease of Adjustment Features Motor

ALL adjustments on the new adjustable shaft motor for pump operation manufactured by Howell Electric Motors Co., Howell, Mich., can be made while the motor is in operation carrying its full load at full speed. The fine micrometer adjustment of the shaft is accomplished by a cast steel housing, accurately machined with 16 threads per inch. By placing a wrench on the micrometer adjustment, a "gallon per minute meter" on the pump and an ammeter on the motor, it can be adjusted to maximum capacity of the pump at maximum efficiency of the motor per horsepower in not more than five minutes.



Changes to adjustable shaft motor for pump operation may be made while motor is in operation

The lubrication chamber of the motor, shown herewith, is totally enclosed at all times while adjustments are being made thus preventing the possibility of injurious materials entering the housing or ball bearings. The assembly is entirely separate from the protecting hood. The new adjustable shaft feature is obtainable for vertical or horizontal motors, constant or multi-speed, and single phase or polyphase.

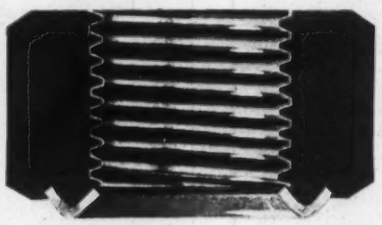
Coating Resists Acids and Alkalies

MANUFACTURED by a secret process from an ore mined in the western United States, a liquid protective coating announced recently by Liquilox Co. Ltd., Los Angeles, contains no dyes, lamp black, rosin, asphalt, gilsonite, vegetable or animal oils. The coating, known as "Liquilox," has been under the process of experimentation for over six years and has proved highly adaptable to the coating of many types of surfaces. It may be applied with either gun or brush to hot or cold surfaces.

The coating offers protection against acids, alkalies, salts, indirect heats (from 1400 to 1500 degrees Fahr.), waters, barnacles, termites, and miscellaneous destructive forces that deteriorate woods, fabrics, metals, etc.

Vibration Is Resisted by Lock Nut

BOTH the up and down movement of the nut on the bolt and the twisting of the nut are eliminated by the use of a new lock nut introduced by Patent A. B. Velock, Stockholm, Sweden. The nut, shown herewith, has a V-shaped locking ring which follows the movements of the seating part, in that way acting as a powerful buffer.



Ring takes up vibrational forces which might affect lock nut

When the nut is tightened the locking ring is pressed in against the bolt threads. Its inside diameter is reduced, and the ring, and the nut are locked on the bolt. All movements along the axis of the bolt are eliminated by the ring, and do not affect the nut. As the nut itself does not come in contact with the seating surface, the vibrations acting on the part do not reach the nut, but are taken up by the locking ring.

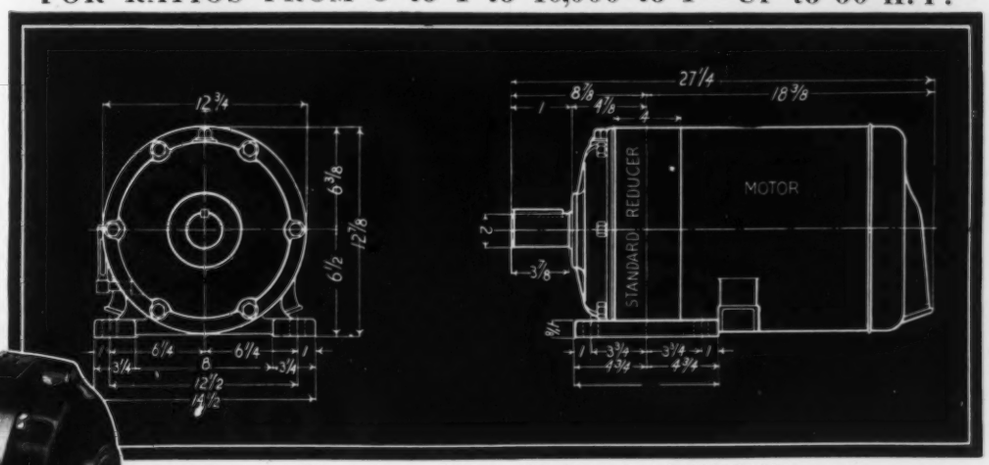
Flexible Couplings Are Redesigned

OPERATING experience with couplings in use has brought about the improved design of the flexible coupling, patented by C. O. Thomas, Montreal, Que., as described in the Oct., 1930, issue of MACHINE DESIGN. The improved form is intended for shafts 6 inches diameter and larger.

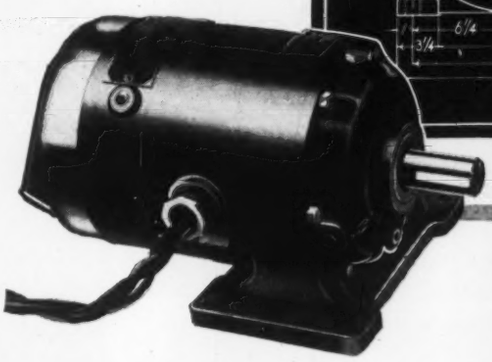
As shown in the accompanying illustration, a jointed casing floats on the spherically formed

Motorized Heliocentric Speed Reducers

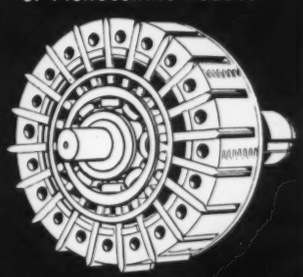
FOR RATIOS FROM 3 to 1 to 10,000 to 1—UP to 60 H. P.



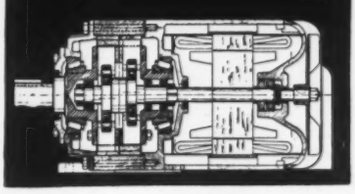
Dimensions of a completely enclosed 5 H. P. Motor and 60 to 1 Heliocentric Speed Reducer



Plungers, Plunger Holder and Eccentric of Heliocentric Reducer



Cross Section View of Motorized Heliocentric Speed Reducer



The Heliocentric Movement Makes Possible This Advanced Type of Motorized Drive

HELIOCENTRIC SPEED REDUCERS because of their unusual design are compact, powerful, efficient units that deliver more horsepower size for size than any other type of speed reducer.

The design of the Heliocentric Speed Reducer permits the electrical parts of the motor to be hung on the reducer, which is just the opposite of the usual motorized speed reduction design. With this arrangement the loads are carried through the reduction unit, which is designed to serve this purpose, instead of through the motor

Size for size and rating for rating Heliocentric Speed Reducers and standard motor parts are of practically the same dimensions. Note in the above dimensional drawing the compact, attractive design of a standard 5 H. P. Motorized Heliocentric Reducer.

Either the standard Heliocentric Straight Line Drive, the Vertical or Right Angle Reducers at any ratio from 3:1 to 10,000:1 and from fractional H. P. to 60 H. P. can be equipped with standard motor parts, eliminating the use of a coupling or base plate.

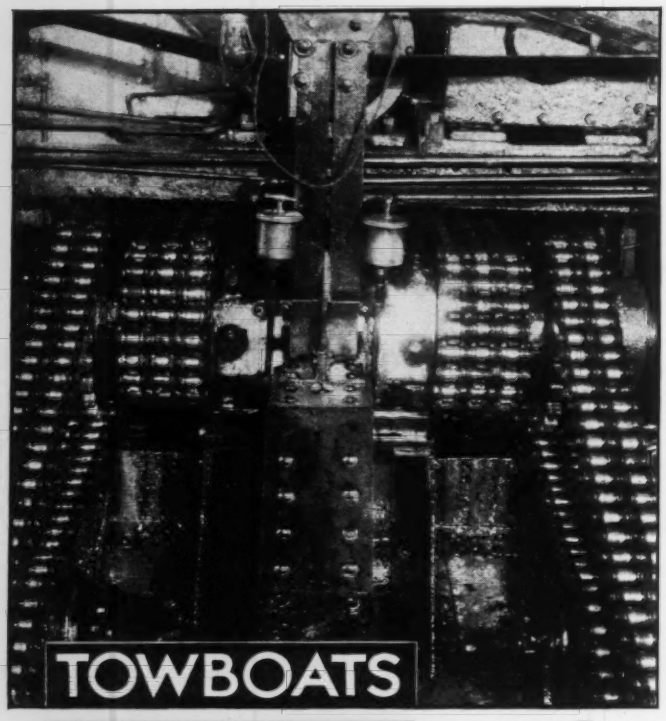
Heliocentric Motorized Speed Reducers are ideal for building into your equipment design, or for laying out your manufacturing arrangement where space and costs are of vital importance.

A full description of Heliocentric Speed Reducers and Heliocentric Motorized Speed Reducers can be obtained by requesting the Heliocentric Catalog No. 100.

UNIVERSAL GEAR SALES CORP.
19th and Martindale
INDIANAPOLIS, INDIANA

HELIOCENTRIC UNIVERSAL GEAR CORPORATION CLUTCH REVOCENTRIC

UNIVERSAL GEAR SALES CORPORATION



TRUST TO CHAIN

River towboats must have thoroughly dependable power units. This engine room view shows how they use Baldwin Chain to help conquer "Old Man River."

* * *

Wherever positive, reliable, efficient power transmission is needed, *plus moderate first cost*, roller chain is very likely to be the best solution. There are thousands of power installations throughout industry on which roller chain is making remarkable showings. Baldwin engineers will gladly give you detailed data on special applications. No obligation, of course.

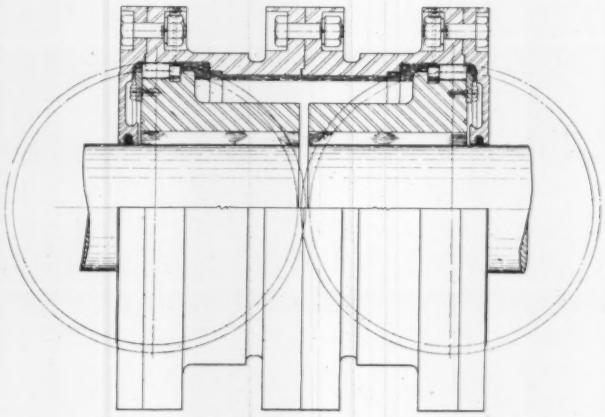
Standard Baldwin Chains and Sprockets in a wide range of sizes and ratios are available from centrally located Baldwin-Duckworth distributors. Use their services.

BALDWIN-DUCKWORTH CHAIN CORPORATION
Baldwin Division, Worcester, Mass.
Duckworth Division, Springfield, Mass.

BALDWIN DUCKWORTH

perimeters of the shaft hubs. Torque is transmitted between the casing and hubs by barrel-shaped rollers in races or holes, bored half their diameter in the hubs and half in the casing. The longitudinal radius of the rollers and spherical radius of the hubs are both centered at the shaft axis. The rollers fit the holes closely so that there is no backlash in the coupling.

When end float occurs, or misalignment exists, movement between the coupling parts is confined to the spherical portion of the hubs and the



Flexible coupling is redesigned following operating experiences

outer semicircumference of the rollers. Sliding of the rollers takes place at right angles to the line of contact, which condition is ideal for lubrication.

The oil storage capacity of the coupling when stationary is such as to submerge the rollers. When in operation, the oil is distributed around the rotating casing by centrifugal action. The driving line of action passes through the rollers at an angle with a tangent to the pitch circle. The sum of the radial components of the line of action at all the rollers holds the casing concentric with the hubs, even though their spherical perimeters may have become worn in long service. For lining up the shafts the halves of the sleeves are moved apart, and each centered upon the shoulders of its companion hub. In this position either sleeve half can be secured by a pair of cap screws if it is desired to run one shaft and not the other.

Safety Panelboard Is Compact

EMPLOYING cabinets only 6 inches deep and 19 inches wide available for flush or surface mounting, the switch and panel division, Square D Co., Detroit, has introduced a line of shallow safety panelboards to augment its line of standard safety panels. The flush mounted cabinets have trims equipped with selfadjusting trim

from COAST *to* COAST

LINDE PROCESS SERVICE IS WITHIN ECONOMICAL 'PHONING DISTANCE

EVERY user of Linde Oxygen is privileged to call upon Linde Process Service for assistance or advice through any of the 25 Linde District Offices.

Linde Process Service, with its unequalled background of scientific research and field experience, offers every facility for most effective use of oxy-acetylene welding and cutting. Here are some of the things it has done.

In the State of Washington, it developed a Procedure Control for welding band saws, thus saving the lumber industry thousands of dollars in replacement costs.

In Iowa, it showed a hosiery mill how to alter forms used in the manufacture of silk stockings, and helped save a capital expenditure of $16,000.

In Minnesota, it showed a steel company how to effect substantial savings in the reclamation of copper tuyeres.

In New York, it showed a manufacturer how to apply iridium to fountain pen points economically and without waste.

These examples illustrate why users of Linde Oxygen gain so much extra value from their use of the oxy-acetylene process. If you are interested in knowing what Linde Process Service can do for you, write or telephone the nearest Linde District Office.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

126 Producing Plants UCC 627 Warehouse Stocks

IN CANADA, DOMINION OXYGEN COMPANY, LTD., TORONTO

District Offices

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Baltimore	El Paso	Philadelphia
Birmingham	Houston	Pittsburgh
Boston	Indianapolis	St. Louis
Buffalo	Kansas City	Salt Lake City
Chicago	Los Angeles	San Francisco
Cleveland	Milwaukee	Seattle
Denver	Minneapolis	Tulsa
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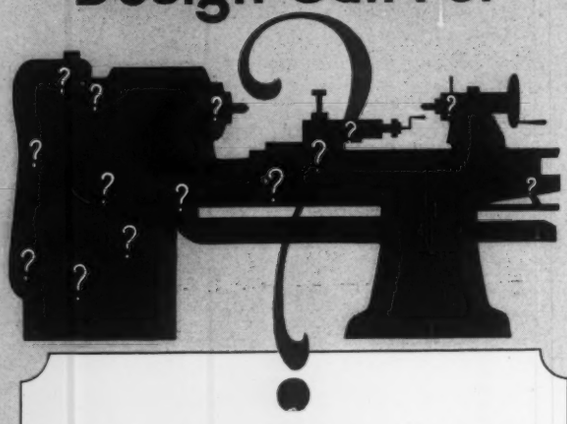
LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES • UNION CARBIDE

What Bearing Service Does Your Machine Design Call For



Is it heat — high speed — low speed — excessive pressure — pounding — strain — acid — or minimum lubrication under which your bronze bearings must operate?

If it is a *super* bearing bronze you want, you will be investing your money in a "sure thing" when you specify

"SABECO"

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THE CERTIFIED BEARING BRONZE

It has proven on numberless occasions that it will outwear any other bearing bronze, under any service condition, at least two times.

Write today for Bulletin—it will pay you to have the facts on hand.

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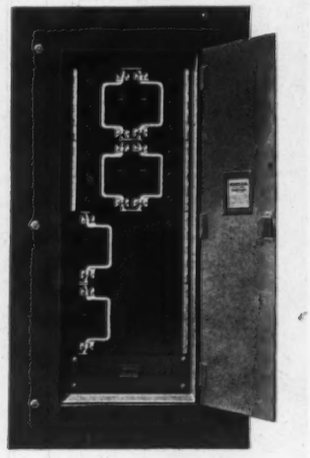
"Know Your Bearings"

"SABECO" METAL
INGOTS, SOLID BARS, CORED BARS, CASTINGS FINISHED TO SPECIFICATIONS
The Certified Bearing Bronze

clamps similar to those used on lighting panels manufactured by the company. Surface mounted cabinets are supplied complete with hinged gutter covers and door.

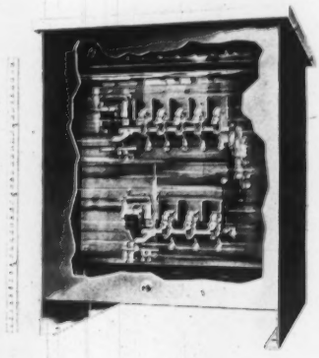
One of the main features of the new line is the fact that combination panels can be built up for applications where a combination power and lighting panelboard conserves space. The new panelboard, shown herewith, offers several refinements such as test holes in the door for fuse tests, swivel blade holders which permit locking the circuit on or off, and flush type door locks and latches. Twin units are convertible between 30 and 60 amperes, 125 or 250 volts while the single units are convertible for 30-60-100 ampere fuse clips, 125 or 250 volts. All units are interchangeable.



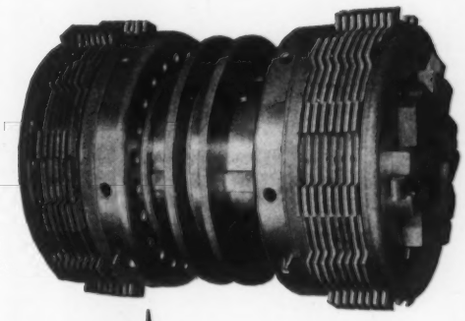
Combination panels can be built up from new safety panelboards which are only 6 inches deep and 19 inches wide

Starter Contacts Open Under Oil

A NEW oil immersed, explosion proof, auto transformer type automatic starter for alternating current squirrel cage motors, has been announced by Cutler-Hammer Inc., Milwaukee. Designed to comply with Underwriters' requirements for Class I, Group D installations, it pro-



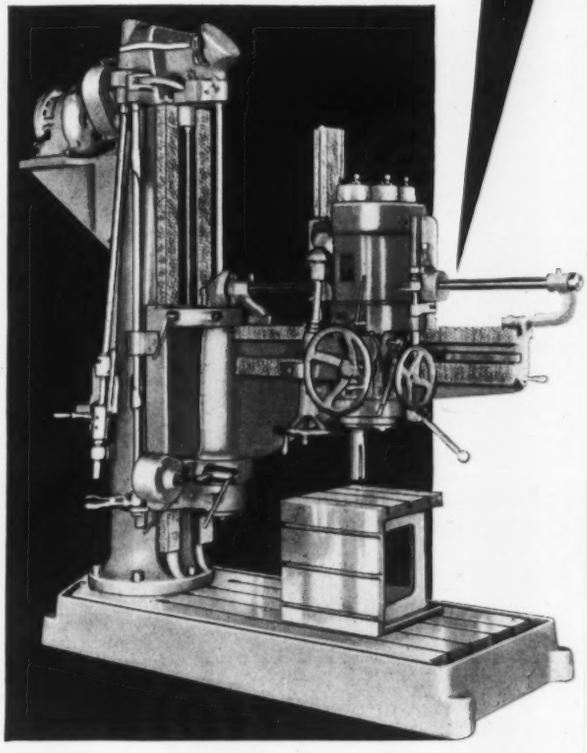
Oil may be replenished on automatic starter without removing the cover



Duplex Action
Close Coupled Type
Twin Disc Clutch

EASIER CONTROL SPEEDS PRODUCTION

THE operator of a Western Low Hung Drive Radial Drill can concentrate on his work without being distracted by the manipulation of the controls. The entire control is in a single lever. With this Twin Disc Clutch equipped control, operation is remarkably easy . . . insuring speedier and greater production.



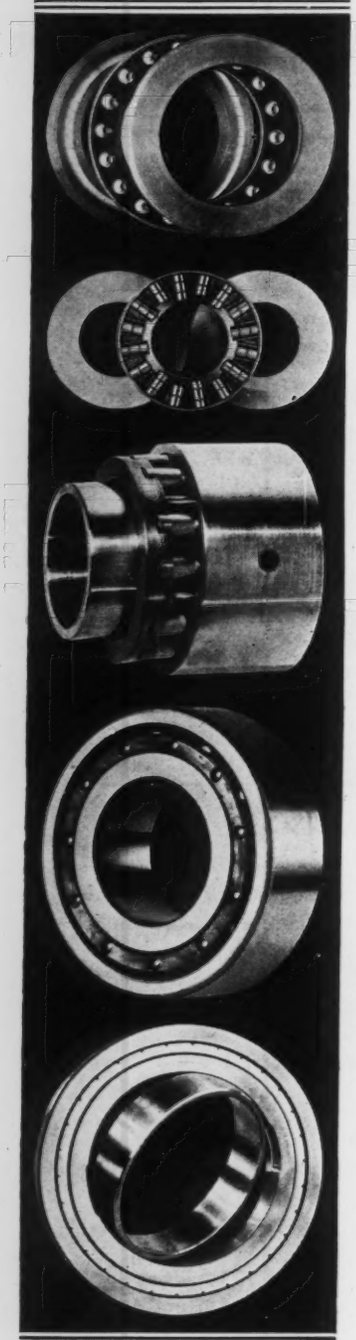
For greater efficiency and less up-keep, the engineers of the Western Machine Tool Works designed this drill with as few parts as possible. It was only natural for them to choose as standard equipment a clutch equally remarkable for its simplicity — the Close Coupled Twin Disc Clutch.

Its hub contains all the operating mechanism . . . centrifugal force operates to release pressure levers. Necessary lubrication is furnished by oil spray. The few adjustments needed are easy to make. Engagement and release are sure and smooth.

Compactness, capacity and all-around adaptability make it the preference of keen designers. There's a size and type for practically every machine tool need—2, 2½, 3, 3½, 4, 4½, 5, 5½, 6, 7 and 9 in. effective diameters; oil or dry plate, single or duplex. Write Engineering Research Dept. for specific recommendations. Engineering Data Book on request. *Twin Disc Clutch Co., 1325 Racine St. Racine, Wis.*

TWIN DISC
CLUTCHES

BEARING SPECIALISTS FOR 32 YEARS



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All types available in self-aligning design.

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ONE OR A MILLION • ½" TO 48"

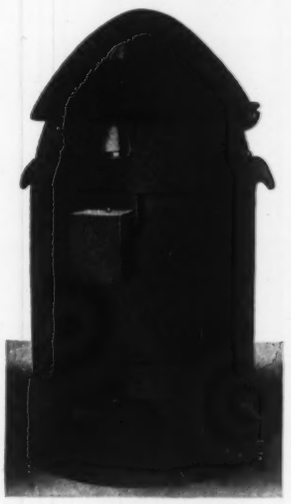
vides a six-inch head of oil above the contacts and incorporates oil level indicator and outside spout for replenishing the oil without removing the cover. Terminals are located above the level of the oil so that the oil will not cause the rubber insulation to deteriorate and cause short circuiting.

The starter panel proper consists of a 3-pole and a 5-pole contactor mounted on a slate panel and interlocked to prevent them from both closing at the same time. The auto transformer and overload relays are mounted on a bracket at the rear of the panel. The panel is fastened to an angle iron frame which slides into channels at the sides of the tank, allowing easy removal.

Applications for this new motor starter include motors in cement mills, flour mills, starch plants, oil refineries, cleaning and dyeing establishments, filling stations, or similar locations.

Announces Motor for Deep Well Pump

DESIGNED especially for deep well pumping service, the construction of the "Bullet Type" vertical hollow shaft motors manufactured by Westinghouse Electric & Mfg. Co., East



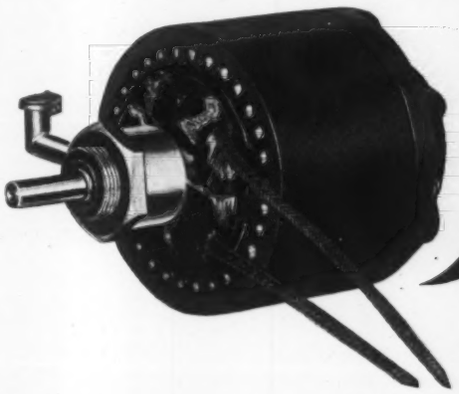
Experience in manufacturing and applying vertical motors to a wide variety of applications results in improvements of hollow shaft motors for deep well pumping service

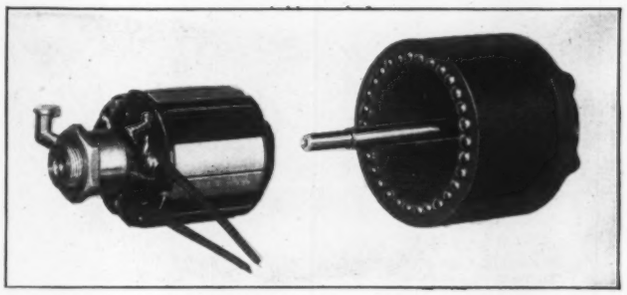
Pittsburgh, Pa., reflects improvements resulting from experience in manufacturing and applying vertical motors to a wide variety of appications.

Many distinctive features are included in the motors, shown herewith, which contribute to economical and reliable pumping operations. Water cannot drip into motor because of its solid frame weatherproof hood. A jaw type clutch protects the equipment from damage in case of power reversals and provides for easy adjustment of the pump shaft. Other features include directed ventilation, liberally designed cartridge type thrust bearings, dual protected and uniform insulation, interchangeable prewound primary core.

Every G-E Motor

is an investment in quality and dependability





G-E Type KL fractional-horsepower motor (assembled view) and, below, same motor disassembled to show construction

EVERY G-E fractional-horsepower motor is an investment in quality because only the best in materials, insulation, varnishes — and above all, the best in engineering and manufacturing practice —goes into its make-up. Every G-E fractional-horsepower motor is an investment in dependability not only because of the inherent high quality of its parts, but because it is exactly the right motor for the drive; nearly thirty years of design, manufacture, and application experience have eliminated guesswork.

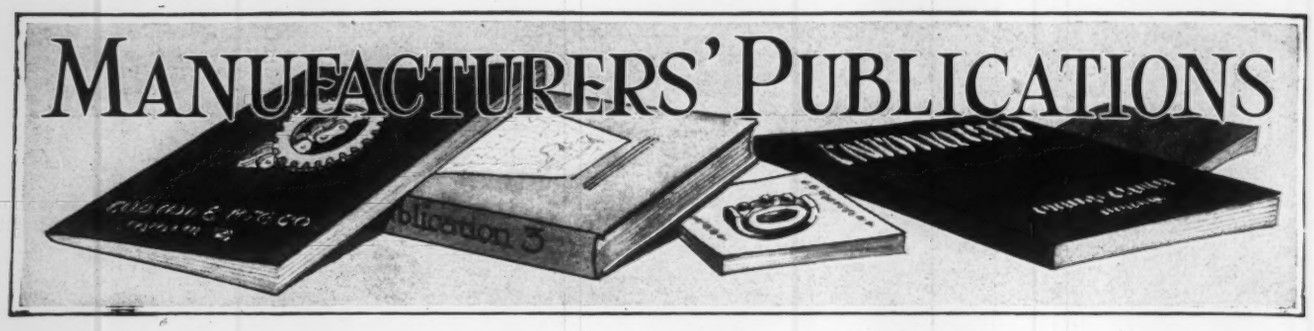
Let G-E application engineers work with you in the solution of your fractional-horsepower motor-drive problems. Investigate this novel design for applications to kitchen ventilators, small unit heaters, and unit ventilator fans. Your nearest G-E office will be glad to "talk motors" with you.

210-146

GENERAL ELECTRIC

SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

BEARINGS—New Departure Mfg. Co., Bristol, Conn., has prepared the eighth edition of its price and data book for ball bearings. The book, conveniently arranged and including much valuable information, contains important revisions and additions to previous listings of types, capacities, dimensions, and mounting details valuable to all engineers and designers.

BRAKE LINING—Number 701 folded and molded industrial brake lining manufactured by Garlock Packing Co., Palmyra, N. Y. is described in a recent bulletin issued by the company.

CLUTCHES—Conway Clutch Co., Cincinnati, has prepared bulletin E-8 which gives a description, engineering data, and general information on its line of full floating, expansion clutches. The equipment is of simple design and rugged construction and has unusually smooth performance.

CONTACT POINTS—"Metallurgy and Design of Contact Points," is the title of a new booklet published by Fansteel Products Co. Inc., North Chicago, Ill. Methods of manufacture, necessity for care in development, and methods of applying the points are some of the topics considered. The bulletin includes tables of dimensions.

DRIVES—Morse Chain Co., Ithaca, N. Y., has prepared bulletin 41 on type 2167 Pumpkin Seed chain for machine tool drives. The chain joint consists of the center pin, or "floater" and two bushings. The action of the floater is to give a uniform, nonpulsating pull in the chain and to carry the forward end of each link on to the sprockets with a minimum rising and falling motion.

DRIVES—Universal Gear Sales Corp., Indianapolis, has prepared a booklet describing in detail the construction, performance and operation of its line of Heliocentric speed reducers. The line comprises a complete series of single, double and triple stage reducers in capacities from ¼ to 150 horsepower, and in ratios ranging from 20 to 1 to 1,000,000 or more to one. They can be furnished in either straight line, vertical or right angle drive.

FASTENINGS—Scovill Mfg. Co., Waterbury, Conn., has issued a 48-page booklet describing and giving dimensions on its line of screw products. Included in the booklet are a description of the thread form and tables of American standard screw threads. The products covered are: cap screws, machine screws, nuts, screw machine products, and specials.

HYDRAULIC DATA—Southwark Foundry & Machine Co., Philadelphia, division of Baldwin-Southwark Corp., has compiled for the use of engineers a booklet on hydraulic tables and general engineering tables. It is designed for the use of the engineer engaged in the design or use of mechanisms for producing loads by hydraulic means. There is included a pipe table and data on accumulators, pumps, intensifiers and shock valves.

MOTORS—Century Electric Co., St. Louis, has issued a bulletin on its repulsion start induction single phase motors. The bulletin discusses in detail the parts and performance characteristics of this type RS motor.

MOTORS—General Electric Co., Schenectady, N. Y., has prepared catalog inserts on the "7600 series" synchronous motors, types TS and QS low-speed synchronous motors, and type SCR explosion-proof, totally enclosed, fan-cooled single-phase motors.

PLASTIC PRODUCTS—General Electric Co., Schenectady, N. Y., has prepared an attractive catalog on its plastic products and the plastics department, and folders on Textolite molded, Cetec cold-molded and Textolite laminated materials.

PLASTIC PRODUCTS—Silent waterproof gears manufactured by impregnating sheets of woven fabric with a synthetic resin are described in a recent publication of Continental-Diamond Fiber Co., Newark, Del. The booklet gives complete information on the gears, and general engineering data.

PUMPS—Single stage, double suction centrifugal pumps of the horizontally split casing design are described and illustrated in a leaflet published recently by De Laval Steam Turbine Co., Trenton, N. J. The pumps are characterized by relatively high speeds, high efficiencies and the ability to work against high heads per stage.

TUBING—Alcunic condenser tubing manufactured by Scovill Mfg. Co., Waterbury, Conn., is described in a recent bulletin prepared by the company. The bulletin, written by W. B. Price, chief chemist and metallurgist, describes the development of the material, and presents charts and tables of test results. Alcunic is an alloy of copper, nickel, aluminum and zinc.

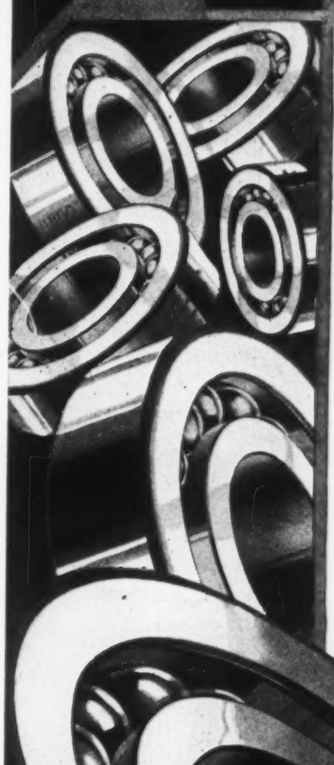
WELDED PARTS—Ells, heads and sleeves for use in welding are described in a pamphlet issued by Midwest Piping & Supply Co., Inc., St. Louis.

WELDED PARTS—The main fields of machine cutting and its importance to the industry, the details of the cutting including limitations, heat effects and gases used, and automatic cutting machines are covered comprehensively in a new booklet "Machine Cutting—A Historical Lesson in Fundamental Economies," issued by General Welding & Equipment Co., Boston.

A Typical Installation

TO THOSE WHO USE BALL BEARINGS

HERE WE TELL YOU HOW AND WHY WE CAN REDUCE YOUR BEARING COSTS . . . . . .



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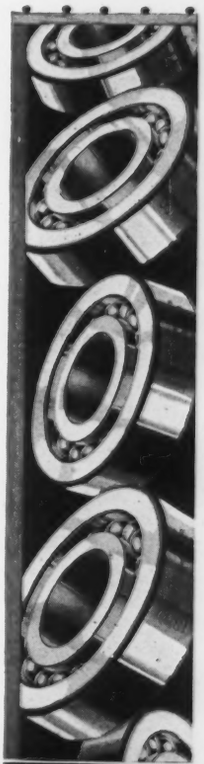

We shall be pleased to forward samples, quotations and complete information to those interested.

THE
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Associated with
THE FEDERAL BEARINGS COMPANY, Inc.,
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Manufacturers of High Grade Precision Annular Ball Bearings

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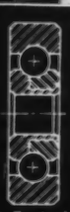

A Typical Installation

"Commercial"